AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

PUBLISHED MONTHLY AT No. 47 CEDAR STREET, NEW YORK.

M. N. FORNEY, . . . Editor and Proprietor.
FRANK J. FRENCH, . . . Business Manager.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid............$3 00
Subscription, per annum, Foreign Countries.......... 3 50
Single Copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

The paper may be obtained and subscriptions for it sent to the following agencies:
Chicago, Post Office News Co., 217 Dearborn St.
London, England, Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C.
Berlin, Germany, W. H. Kühl, 73 Jäger St.

NEW YORK, MARCH, 1895.

EDITORIAL NOTES.

ATTENTION is called to the paper on the Deterioration of Locomotive Boilers through the Effects of Expansion, the publication of which is commenced in another column. It is written by Herr Lentz, the designer of the stayless boiler, and contains a great deal of valuable information regarding the strains to which steam-boilers are exposed, which has been ascertained by his own and the experiments of others.

THE action of the railroads centring in Chicago relative to the modification of the Rules of Interchange has had the apparent effect of causing the General Committee of the Master Car-Builders' Association to send out a circular asking for the opinions of the members as to the advisability of so modifying the rules that owners are liable for all ordinary repairs, and that inspection shall be for safety rather than pecuniary protection. The rules of interchange, simple in their first formulation, have grown by yearly accretions and the decisions of the Arbitration Committee, until they are now such a ponderous mass that the layman makes no pretence of understanding their conditions. It would seem that they have become so heavy that they are about to go to pieces by their own weight.

WE recently had occasion to note that the immunity from serious damage shown by the Chinese armored battleships in the Yaloo fight was to be used before the Naval Committee as an argument for the construction of additional armored battleships for the United States. It seems that this argument has had a further strengthening by the action of the Japanese, who have taken advantage of the experience gained in this war, and have ordered two battleships that are to be built on the Thames. They are to have a displacement of 12,250 tons, a length of 370 ft., a breadth of 73 ft. The armor is to extend for 226 ft., and is to be from 10 in. to 18 in. in thickness. The H.P. is to be 4,000. Two 12-in. breech-loading rifles will be behind 14 in. of armor. Such is one of the practical naval lessons of the war, and the first steps of Japan toward the assumption of a place as a maritime power, her present navy consisting of cruisers and torpedo-boats.

POSSIBLE SOURCES OF FUEL ECONOMY IN LOCOMOTIVES.

LAST month we published some comments on a paper read before the Western Railway Club by Mr. William Forsyth, on Locomotive Fuel, which contained a special inquiry into "the heat values of Western coal." In this paper he made the statement that the fuel used in 1893 on the road with which he is connected (the Chicago, Burlington & Quincy) cost $1,291,108. In his paper he says, further, that "in 1885 the Chicago, Burlington & Quincy Railroad Company had an exhaustive series of tests made of all the Illinois coals that were then used." The results of these tests were given in a table in which "Streator" coal was taken as the standard, the cost of which at the mine was $1.30 per ton. He then gives the comparative evaporative value of 17 different kinds of Illinois coal, the cost of each at the mine, and the actual value compared with Streator coal. Thus the comparative evaporative value of Streator coal being assumed to be 1, that of the second on the list was only .724, so that if Streator was worth $1.30 per ton, then relatively the second sample was worth only $1.05, whereas it cost $1.45, which means that if the company bought that kind of coal they would be paying 38.1 per cent. more for it than its actual worth. The third sample was shown to have a relative value of .793, and was therefore worth only 99 cents and cost $1.25, so that its price would be more than 26 per cent. greater than its value.

The average cost of the 16 inferior qualities of coal tested was $1.34, and its average comparative value was only .857 and its actual value $1.15, so that if the orders of the company had been distributed equally among those 16 kinds of coal instead of buying Streator, the loss would have been 19 cents per ton, or over 14 per cent.

The importance to a railroad company of knowing the relative *value* of the coal it buys is obvious. In the case before us, if the Chicago, Burlington & Quincy Railroad Company had bought none but the second kind of coal instead of Streator it would have lost $491,912.14; and if it had been supplied with the third kind the loss would have been $339,561.40; and if it had distributed its orders equally among all the kinds of coal used, the loss would have been $180,755.12. The additional expense of handling the greater quantity of coal required would doubtless have run the excess of cost up to $450,000, $350,000, or $200,000 in these hypothetical instances.

The purpose of Mr. Forsyth's paper and the object of making these calculations was to show the importance to a railroad company of knowing what the *actual* value is of the fuel which it buys. This should be determined by some adequate tests, and not be a matter of mere surmise. It is hardly necessary to add that ordinarily the value of the fuel which is bought and used by railroad companies is not ascertained by any investigations or tests worthy of credence. Too often, too, like the osculatory exercise, the purchase of coal goes by favor and not by merit alone. Some director or director's friend is interested in a coal mine, and his influence is sufficient to secure the orders for fuel, whether it is the best or not, and the superintendent of machinery is made to understand that tests of it would be distasteful to those who are higher in authority than he is, and so the company goes on and uses inferior fuel for years at a loss to its stockholders, but with a profit to the owners of the coal mine. The points which it is intended to em-

phasize here are, first, that comparatively few companies ever make any comparative tests of fuel which are reliable; and, second, that it is of very great importance from an economical point of view that they should, and that the probabilities are that on most roads a considerable saving could be made if the coal used was subjected to rigid tests to ascertain its actual value. In these hard times it would seem as though every railroad company would want to know with absolute certainty what the real value is of the fuel which it buys.

There is no source of economy in locomotives which has probably received more attention than that of the valve gear and the distribution of steam in the cylinders. Notwithstanding that so much thought, ingenuity and experiment has been devoted to it, it is still true that in nearly all locomotives, especially those which run at a high speed, there is a very consid-

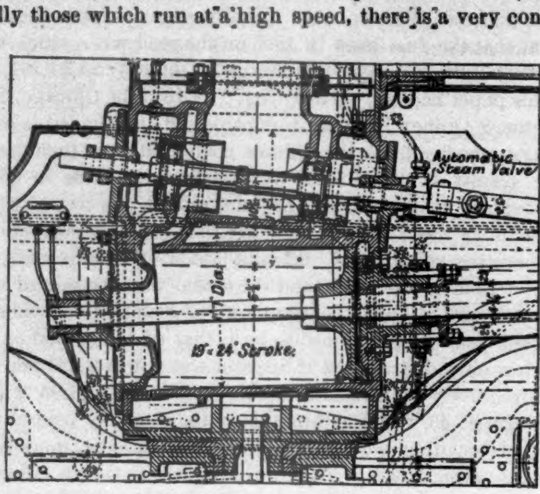


Fig. 1.

SECTION OF PISTON AND VALVE, EXPRESS LOCOMOTIVE NORTHEASTERN RAILWAY.

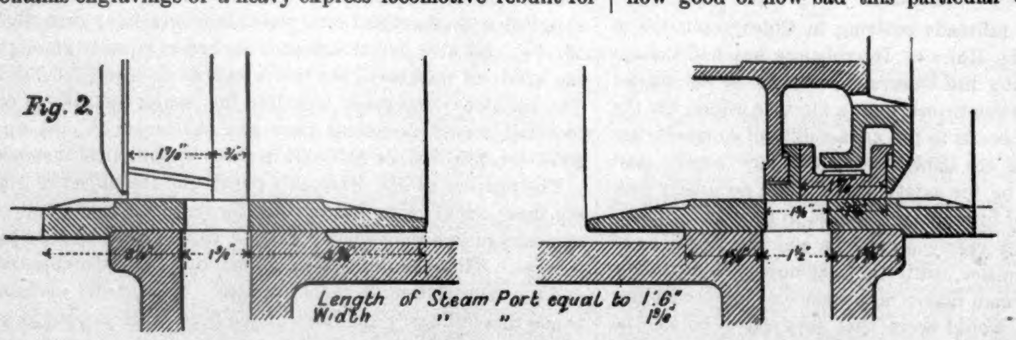
erable loss of economy, partly from an imperfect admission of steam to the cylinders and also from back pressure resulting from imperfect valve gearing and contracted exhaust nozzles. These difficulties have seemed to be almost inseparable from the use of the link motion; and some months ago * the query was suggested in these columns whether a return to some of the old forms of valve gear, in which separate cut-off valves were used, or some modification thereof, might not be attended with advantage. A late number of *Engineering* (February 1) contains engravings of a heavy express locomotive rebuilt for the Northeastern Railway of England, with a single pair of driving-wheels 7 ft. 7½ in. diameter, showing the valve gear and indicator diagrams taken therefrom. These are calculated to lead to the inference that a separate cut-off valve may not be needed in order to get a practically perfect distribution of steam in locomotive cylinders even at speeds as high as 60 miles an hour. We reproduce herewith fig. 1, which shows a sectional view of the cylinders and steam-chest of this engine.

* April last.

The cylinders are 19 in. diameter, and are inside the frames and connected to a cranked axle of the usual English type. Two pistons 8 in. in diameter form the valves. An enlarged section of the steam ports is shown in fig. 2, the packing of one of the valves being also shown in section in the right-hand side. The lap, it will be seen, is 1¼ in. The throw of the eccentrics is 5¼ in., but the eccentric rods are connected to the ends of the links so that the full throw of the eccentrics is not communicated to the valves. A single exhaust nozzle is used, which on one of the engravings is marked 4¾ in. and on another 5⅛ in diameter. On a third view it is represented as of smaller diameter than on either of the others, but the dimension is not given. We are not able to reconcile these differences unless it be that in some way the size of the nozzle is adjustable in a manner not clearly shown in the engravings. Figs. 3 to 11 represent indicator diagrams taken with this gear. Our readers will, we think, agree with us in thinking that these diagrams are very remarkable. Probably no link-motion valve gear has ever shown such a perfect distribution of steam. The corners at the points of admission and cut off, it will be seen, are as sharp as though drawn by a skilful draftsman, and in some of the diagrams the expansion curve is slightly better than a theoretical curve would be. It would be interesting to know the particulars more fully and the conditions under which these diagrams were made. There is nothing remarkable about the link or its connections. Is the perfection of these diagrams due to some peculiarity of the piston valves or of the exhaust nozzles? It will probably be safe to say that these diagrams, if compared with the average of steam distribution on ordinary locomotives, would represent an economy of at least 10 per cent. in the consumption of steam. If this is due simply to the design of the valves or their gear we have an economy which is not dependent upon any unattainable perfection of skill or discipline in the men, but which would be inherent in the mechanism of the gear. It may be added that it is stated by the *Engineer* that "this type of engine was originally designed by Mr. Thomas W. Worsdell, when Locomotive Superintendent of the line, it being then fitted with compound cylinders; but in the course of rebuilding, as the cylinders required renewing, the engines have been fitted by Mr. Thomas Worsdell, the present Locomotive Superintendent, with non-compound cylinders provided with piston valves, *and with very satisfactory results.*" (The italics are ours.) It cannot be assumed that this is conclusive evidence against compound engines, because we don't know how good or how bad this particular compound engine was which was altered. To replace a bad compound engine with a good simple one may be a gain, while such a change would not be desirable if a compound locomotive was of the best type. Of the change, however, by parties who at one time had sufficient confidence in the compound system to give it a very thorough trial, it may be observed—as some one did when he found a live trout in the milk—that "it was strong circumstantial evidence." What is especially pointed out here is that if a perfection of valve gear equal to that which is shown by the indicator diagrams which Mr. Worsdell has made is attainable, it would represent a considerable economy, which it may be assumed would be equal to 10 per cent.

Last month we reprinted a table (page 60) showing the per-

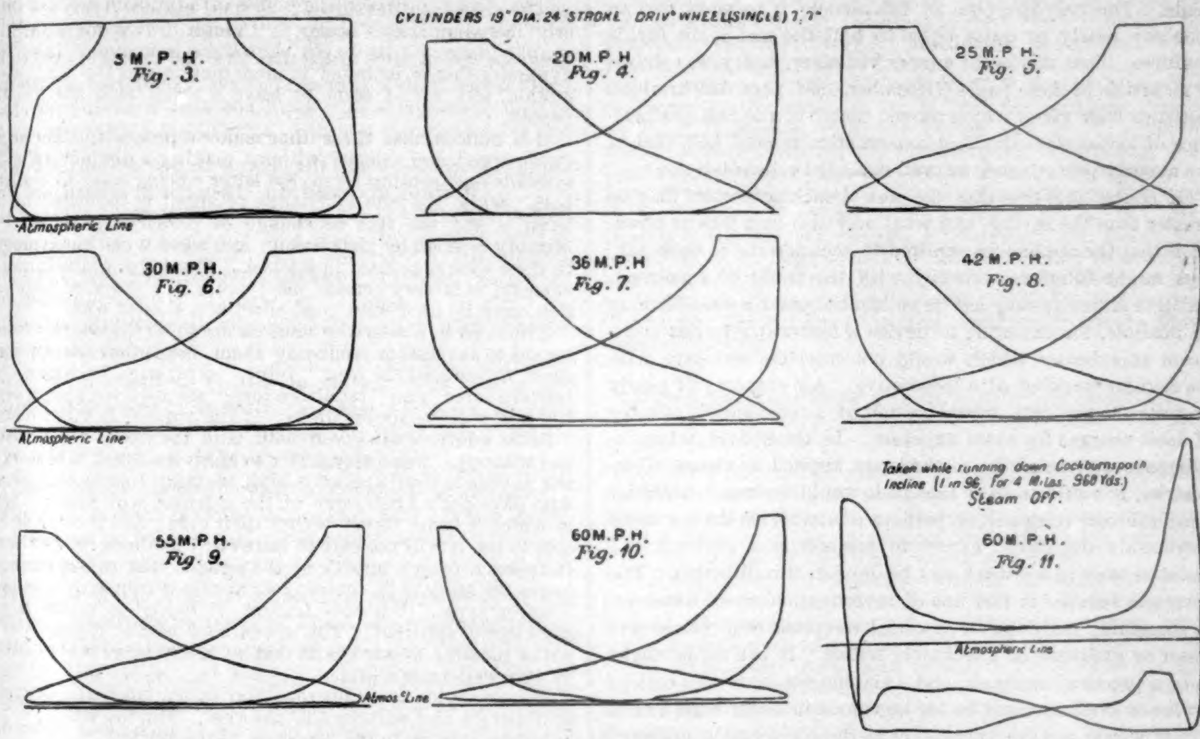
Fig. 2.



VALVE ARRANGEMENT, EXPRESS LOCOMOTIVE NORTHEASTERN RAILWAY.

centage of saving of fuel by heating feed water. That table showed that with feed water having an initial temperature of 60° there would be a saving of 14 per cent. if it was heated to 220° with steam at 60 lbs. pressure. It would be about 13 per cent. for steam of 175 lbs. Another table published with this number and compiled by another manufacturer of feed-water heaters agrees very closely with the one we gave last month. That such a theoretical saving is possible by heating feed water can be demonstrated, and has been proved practically a great many times. But feed-water heaters have been tried on locomotives a hundred or more times and have always been abandoned, notwithstanding their economy. The reason seems to be this: the urgent and obvious end to be attained on a railroad is to get the traffic—that is, the cars to be hauled—over the road. Sometimes this must be done with insufficient equipment in the motive power department. At such times if one or more locomotives are disabled the delay, inconvenience and annoyance of having traffic congested is at once apparent to all who are responsible for the working of the road, and it then fails in its primary purpose, end and aim. Consequently there is a storm of indignation at once. If the cause is feed-water heaters, the argument is apt to be expressed profanely, and the locomotive superintendent is or may be ordered to take off these —— heaters. Now, supposing that there is an increased consumption of coal as a consequence of their removal. Probably few people will ever know it. The trains will or may be going over the road regularly day after day, and unless some one with an aptitude for statistics should analyze the accounts of fuel consumption, or if no such accounts are kept, no one will know whether 13 per cent. more or less of coal is burned. The locomotive superintendent and his subordinates might be happy under these circumstances, and the superintendent and manager be content in their ignorance, whereas if an apparatus which was saving a considerable percentage of fuel should delay a few trains, probably the lot of the locomotive men would not be a happy one. Now the question arises whether it is not possible to devise a feed-water heater which would not be liable to get out of order, or which, if it did, would not delay the engine to which it was attached, and the maintenance of which would not be so costly as to eat up all or most of the theoretical saving? Feed-water heaters are very commonly used on stationary engines, and are found to be economical and reliable in that service. It is hard to see why there should be any inseparable obstacle in the way of their use on locomotives.

Last month (page 89) an account was also published of some experiments made at Durlach (which, it was erroneously stated, was in Switzerland; it in reality is in Bavaria) with Schmidt's superheated steam boiler and engine. Some remarkable results are reported with this. There can be no doubt of the economy resulting from the use of superheated steam, and with improvements which have been made of late years in lubricants which can now be obtained to withstand higher temperatures than animal oils will, a degree of superheating seems to be practicable which a decade or more ago always resulted in failure. An economy of about 20 per cent. seemed to be indicated by the experiments referred to. The great saving due to the use of superheated steam has long been known; the difficulties have always been in the practice and not in the theory. Our correspondent wrote that "this subject is being steadily investigated over here." There is good reason for expecting important advantages from this source.



INDICATOR DIAGRAMS FROM EXPRESS LOCOMOTIVE NORTHEASTERN RAILWAY. DIAGRAMS TAKEN WHILE WORKING AN EXPRESS TRAIN BETWEEN NEWCASTLE AND EDINBURGH.

LOAD, 14 COACHES, ENGINE 1519 (PISTON VALVES), OCTOBER 20, 1894.

As we are not aiming at strict accuracy, but only making a probable hypothesis, it may be stated that an economy of about 14 per cent. seems to be possible by simply ascertaining the relative quality of coal bought. In other words, the experience on the Chicago, Burlington & Quincy Railroad indicates that the best coal on that line is 14 per cent. better than the average; and if a railroad company or any other purchaser has no means of knowing which is the best, they are likely to get an average.

Second, the difference resulting from the use of a perfect

valve gear compared with one which is imperfect may and probably would be as much as 10 per cent or possibly more in the fuel consumption.

Third, a saving of 14 per cent. seems to be possible from the use of a feed-water heater.

Fourth, a saving of 20 per cent. appears to be within reach by using superheated steam.

Let it be assumed that the fuel consumption on a road is represented by $1,000,000; if 14 per cent. was saved by simply testing it and learning which was the best quality to buy, the $1,000,000 would be reduced to $860,000. If, now, we save 10 per cent. by an improved valve gear, the million is reduced to $774,000. If feed-water heaters should save 14 per cent., then the cost of fuel would be lowered to $665,640; and if superheated steam should fulfil its promise of 20 per cent. saving, the fuel account would be brought down to $532,512. Now, of course, there will be a debit side to this account to which it would be impossible perhaps now to assign any even approximately correct value, and the attempt will not be made. The only purpose of this article is to show that an economy nearly or quite equal to half the cost of the fuel is possible. That this is not a mere visionary theory was shown in an article in these pages (December, 1894, page 532) in which statistics were given which proved that "in the best performance of locomotives the fuel consumption is *only half* that of the average performance on well-managed railroads."

Of course it is true that the cost of such economies may be greater than the saving, and what may also be a serious obstacle is that the appliances required to secure some of these savings might interfere seriously with the traffic of a railroad. But this difficulty may not be an insurmountable one. It may be possible, for example, to devise a feed-water heater and a steam superheater which would not interfere seriously with the regular working of a locomotive. An economy of nearly or quite 50 per cent. would permit of a considerable number of debit charges for extra expenses. In these days, when intelligence and scientific methods are applied to almost all industries, it would seem as though it would be worth while for some railroad company or perhaps a number to employ some thoroughly competent expert to proceed in a cautious and tentative way to see what may be done in this direction. The person to succeed in this line of investigation must, however, be something more than a practical mechanic or a college professor or graduate of a technical school. It is true, he ought to be a practical mechanic and have the resources of a college professor available, and be an ingenious inventor with a head which would always be as level as the surface of a quiescent pond. Wanted, such a person, and one or more railroad companies with sufficient intelligence, liberality and enterprise to employ him to make investigations on the lines indicated.

NEW PUBLICATIONS.

THE ELEMENTARY PRINCIPLES OF MECHANICS. VOL. I. KINEMATICS. By A. J. Du Bois. New York: John Wiley & Sons. 225 pp.

Mechanics is a typical science. Its fundamental principles conform so perfectly with nature that the results derived therefrom are considered as interpretations of nature. The mathematician includes in his formulas the whole planetary system, and uses his analysis in the discussion of phenomenon so remote as to require decades of years for the physical phenomenon to reach the earth.

The foundation for this grand science was laid by Galileo nearly 300 years ago in his discovery of the simplest of the laws of motion, and Descartes added an impetus to the ideas thus promulgated. Newton less than 150 years ago established his law of gravitation, and La Grange about a century ago published his incomparable work, "Le Mécanique Analytique," in which he proposed to establish general formulas, the simple development of which would enable one to solve special problems. In his day this subject was studied by very few, and no attempt was made to teach it in general courses of instruction, and the style in which La Grange presented the subject was adapted only to mature and strong-minded students. L'École Polytechnique, however, which contained in its faculty La Place, La Grange, Poisson and others, taught it in all its severity. It sometimes requires the labors of a variety of minds and years of effort to modify methods of analysis and processes of reasoning so as to make a subject available for the average student. This fact makes excusable the production of many books upon a science, although some of them may fall short of the ideal standard of an expert.

There has been a tendency of late years among writers to treat mechanics under three heads: Kinematics, Statics and Kinetics. There is an advantage in this, since it enables the writer to keep more prominently in view one particular thought, and to develop that more thoroughly; but there is a disadvantage by separating the solution of higher problems into parts, one part being in one place and the remaining part in another, the different places sometimes being in different books. To a student who acquires a thorough knowledge of the subject, the advantage of the former probably greatly outweighs the disadvantage of the latter.

The work before us treats only of kinematics, and the subject is very fully developed. Several modern terms are properly introduced, as "scalar," "vector," "hodograph." A simple glance at its pages shows one how much there is in dynamics that is included in mere motion and the relations of motion, and would seem to leave a small field for kinetics proper.

It is noticed that the author makes a proper distinction between speed and velocity without making a distinction in the symbols representing them, the letter *v* being used to indicate both; while the rate of change of speed is indicated by the letter *a*, and the rate of change of velocity by the letter *f*. Memory is aided by association; and when it can conveniently be done should be used in science. The letter *v*, the initial of velocity, is in very general use; and *a*, the initial of acceleration, may be used with good effect in a similar way.

Although in kinematics motions are to be discussed without regard to the agents producing them, the author has, in some cases, introduced the term "force," as on page 99, where "attractive force" and "repulsive force" are used to explain negative and positive accelerations. It also appears in other places.

Some solutions are given both with the use of the calculus and without. Some may prefer to study a subject in this way; but as time is short and art is long, we fancy that most students who have not a knowledge of the calculus will prefer a book in which it is not thrust before their eyes; and those who are able to use it will not care to have other methods in their way. It appears, from a remark of the author, that it was intended to aid the student in choosing an abridged course by means of "larger type;" but this feature, if indeed it exists, is not sufficiently apparent. The appearance of the typography is not as pleasing to our eye as that of many other works issued by this well-known firm.

The examples are numerous and varied, and well designed to illustrate and enforce the theories. On the whole, it is a valuable addition to the literature of the subject.

"SCIENCE." This paper, after a brief suspension, also comes in a new form, the pages of which are a little larger than the ordinary magazines. It will hereafter be conducted by the following editorial committee: S. Newcomb, Mathematics; R. S. Woodward, Mechanics; E. C. Pickering, Astronomy; T. C. Mendenhall, Physics; R. H. Thurston, Engineering; Ira Remsen, Chemistry; Joseph Le Conte, Geology; W. M. Davis, Physiography; O. C. Marsh, Paleontology; W. K. Brooks, Invertebrate Zoölogy; C. Hart Merriam, Vertebrate Zoölogy; N. L. Britton, Botany; Henry F. Osborn, General Biology; H. P. Bowditch, Physiology; J. S. Billings, Hygiene; J. McKeen Cattell, Psychology; Daniel G. Brinton, J. W. Powell, Anthropology.

It is published at 41 East Forty-ninth Street, New York.

ELASTICITAET UND FESTIGKEIT (ELASTICITY AND STRENGTH OF MATERIALS). By C. Bach, Professor of Mechanical Engineering, Technical High School, Stuttgart, Germany, with Illustrations and 15 Photogravures. Second Edition. Berlin: Julius Springer, 1894. 432 pp., 6 × 9 in.

The typographical work in this book and the paper on which it is printed are so much superior to the ordinary books of similar nature printed in this country, that they are worthy of notice. The photogravures are illustrations of test specimens, and aside from being interesting and instructive, are artistic in execution.

The general features of the book, as well as its value, are pretty accurately set forth in the preface.

The work is largely mathematical, but it is written with unusual clearness, and each subject is practically complete within itself. It is divided into seven parts, these being subdivided into chapters and paragraphs. The paragraph is really the unit, and, as the number of each is printed at the head of the page on which it appears, it becomes very easy to look up a reference when one is made to another paragraph.

The first part treats of straight beams subjected to simple cases of tension, compression, bending and buckling. In this part the author substitutes for the commonly used modulus of elasticity a "coefficient of elasticity," this coefficient being simply the reciprocal of the well-known modulus. He defends this change very justly as being in the direction of reason, being more readily used from the fact that it is applied directly rather than in a reciprocal manner, and that it is a fact which needs no assumption of impossible conditions ; later on he introduces also a coefficient of shear rather than a modulus of shear.

The mathematical determinations are supplemented by the results of original experiments made by the author, and also by results from other sources. The change of form and nature of fractures is clearly illustrated in the plates, and this experimental feature is common to most of the articles ; it is one of the most interesting parts of the work.

The author shows that the coefficient of elasticity for some materials, commonly considered constant within certain limits of strain, is not so in cast iron, a material so commonly used in the construction of machinery. The law of variation for this is given graphically.

The influence of different shapes of test pieces on the results is clearly shown, especially in relation to cast iron.

The second part treats of torsion and shear in straight beams. Torsion of beams of other section than circular are treated at considerable length. The subject is elaborated by experiments and well illustrated by photogravures showing nature of changes.

The third part treats of work performed in the elastic changes under the conditions treated in the previous parts

The fourth part treats of the effect of combined stresses in straight beams, such as tension, shear, etc. This part is particularly instructive in showing the fallacies which often exist in proportioning parts for one kind of strain only when another is present and is really the more important.

The fifth part treats of the effect of stresses in beams which are not originally straight. The hook is specially discussed.

The sixth part treats of the strains in cylindrical and spherical vessels subjected to liquid pressures from inside and out.

The seventh part treats of flat plates of various shapes subjected to pressure, as, for instance, manhole covers, etc.

The book is of value to the student from its clear mathematical determinations, some of which are evidently new in method at least. It is also of value to the practical man who does not wish to spend a great deal of time in following the author through his demonstrations from the experimental data given and from the fact that at the end of each subject treated the result arrived at is given in a very concise manner in double-leaded type.

Proceedings of the International Electrical Congress, held in Chicago, August 21–25, 1893. Published by the American Institute of Electrical Engineers, 26 Cortlandt Street, New York. 488 pp., 6 × 9¼ in. $3.

The proceedings of this notable gathering of electricians will be warmly welcomed by electrical engineers generally. It covers so broad a field that a review in the space that is available is impossible. We must therefore content ourselves with simply a list of papers and discussions, which is as follows :

Opening of Congress ; Proceedings of the Chamber of Delegates ; Proceedings of Section A ; On the Analytical Treatment of Alternating Currents, by Professor A. Macfarlane ; Complex Quantities and their Use in Electrical Engineering, by Charles Proteus Steinmetz ; General Discussion of the Current Flow in Two Mutually Related Circuits Containing Capacity, by Frederick Bedell, Ph.D., and Albert C. Crehore, Ph.D. ; Explanation of the Ferranti Phenomenon, by Dr. J. Sahulka ; Measurements of the Energy of Polyphase Currents, by A. Blondel ; The Extended Use of the Name Resistance in Alternating Current Problems, by Professor W. E. Ayrton ; Proceedings of Section B ; Signalling through Space by Means of Electric Magnetic Vibrations ; Ocean Telephony, by Silvanus P. Thompson, D.Sc., F.R.S. ; Materials for Wire Standards or Electrical Resistance, by Dr. Stephen Lindeck ; Some Measurements of the Temperature Variation in the Electrical Resistance of a Sample of Copper ; Note on Photometric Measurement, by Professor B. F. Thomas ; A Pair of Electrostatic Voltmetres ; On a Method of Governing an Electric Motor for Chronographic Purposes ; Iron for Transformers, by Professor J. A. Ewing, F.R.S. ; London Electrical Engineering Laboratories, by Professor Andrew Jamieson, Member Inst. C. E., F.R.S.S.E., etc. ; Transformer Diagrams Experimentally Determined, by Dr. Frederick Bedell ; On an Improved Form of Instrument for the Measurements of Magnetic Reluctance, by A. E. Kennelly ; Variation of P. D. of the Electric Arc with Current, Size of Carbons and Distance Apart, by Professor W. E. Ayrton, F.R S. ; Light and Heat of the Electric Arc, by M. J. Violle ; On the Maximum Efficiency or Arc Lamps with Constant Watts, by Professor H. S. Carhart ; The Periodic Variation of Candle Power in Alternating Arc Lights, by Benjamin F. Thomas, Ph.D. ; New Researches on the Alternating Current Arc, by A. Blondel ; On the Continuous Current Arc and Its Employment as a Photometric Standard, by A. Blondel ; On the Source and Effects of Harmonics in Alternating Circuits, by H. A. Rowland ; Proceedings of Section C ; Rotary Mercurial Air Pumps, by Dr. F. Schulze Berge ; Underground Wires for Electric Lighting and Power Distribution, by Professor Dugald C. Jackson ; Various Uses of the Electrostatic Voltmetre, by Dr. J. Sahulka ; A New Incandescent Arc Light, by Louis B. Marks ; Direct Current Dynamos of very High Potential, by Professor Francis B. Crocker ; Multiphase Motors and Power Transmission, by Dr. Louis Duncan ; Exhibit of Tesla Polyphase System at the World's Fair, by C. F. Scott ; Discussion on Power Transmission, by Dr. L. Bell, Mr. Stillwell, Professor S. B. Thompson, Professor Forbes and Mr. C. P. Steinmetz ; A Novel Method of Transforming Alternating into Continuous Currents, by Dr. Charles Pollak ; Discussion on Power Transmission, Continued, by Professor Forbes, Professor H. A. Rowland, Professor D. C. Jackson, Dr. L. Bell, Mr. Charles S. Bradley, Mr. Charles P. Steinmetz, Dr. Keith, Mr. Lemp, Mr. F. C. Hasson, and Dr. Louis Duncan ; Note on the Variation of Capacity of Insulated Wires with Temperature, by Herman S. Hering ; The Tesla Mechanical and Electrical Oscillators ; International Electrical Congress Banquet ; Final General Meeting.

Practice and Theory of the Injector. By Strickland L. Kneass, C.E. New York : John Wiley & Sons. 132 pp., 5¾ × 9 in. $1.50.

Usually a reviewer is assisted in learning an author's aim and scheme in writing his book by a preface. In the present instance, as there is no such introduction, the book itself and what it contains is the only source from which we can learn what the purpose of the author was in writing it.

The beginning is a chapter devoted to the early history of the injector from its invention in 1858 by Henri Jacques Giffard—to whom the honor is due—down to the present time, when, as the author tells us, more than 500,000 of these instruments or machines have been manufactured in this country. The next chapter is devoted to an account of the development of the principle of this wonderful appliance. Both of these chapters are admirably clear and satisfactory. They are followed by another short one which is very excellent in its purpose and execution. Its title is Definition of Terms—Description of the Important Parts of the Injector—Their Functions. This will be a great help in bringing about a uniform nomenclature. This purpose would have been still further promoted if a good engraving, as large as the page would admit, of a modern injector had been given, with names of the different parts either inscribed on them or indicated by reference letters, with a list of names appended.

The three following chapters are devoted respectively to The Delivery Tube, The Combining Tube, and the Steam Nozzle—Efficiency of Various Types—Effect of Different Shapes and Proportions. A theoretical investigation of the functions of each of these parts and accounts of experimental investigations are given. These chapters are followed by another on The Action of the Injector, which contains a full statement of its theory, to a considerable extent treated mathematically, the results of which are checked off by reference to experimental investigation.

Chapter VIII is on Application of the Injector—Foreign and American Practice—Description of Various Patterns of Injectors, in which the machines made by different makers are illustrated and described.

A word of criticism of the illustrations would seem to be in order here : none of them are very good, and some are very bad, notably those on pages 91 and 92. In these days of cheap engraving there is no excuse for an author or publisher giving his reader an ugly blotch like that on page 91. In describing complicated mechanism, the draftsman's art is as essential as

the skill and lucidity of an author. The writer of the book under review signs himself C. E. Now, it is a curious fact that most civil engineers seem to hold in contempt, or at least do not assign to the art of a draftsman, its real value, especially in the exposition of mechanical subjects. Let it be hoped that for a future edition the author will secure the co-operation of a good mechanical draftsman, who is well up in the æsthetics of his craft. Such assistance would add immensely to the pleasure with which the book may be read, and would greatly facilitate a comprehension of it. Vituperation of this kind, however, aimed at a minor fault, is perhaps partial injustice to an author who has given us an excellent book on a subject of which heretofore there has been no satisfactory exposition.

In the concluding chapter some excellent recommendations are given with reference to the size of injectors which should be used, and the methods of testing them. The handling and repair of injectors is treated in two short paragraphs at the end of the last chapter. Not sufficient attention or space seems to have been given to this branch of the subject, considering how many persons are interested in it. A comprehensive chapter on the *pathology* and another on the *therapeutics* of injectors would doubtless be gratefully received by those who have the care and must operate such instruments, which are often the cause of much anxiety and provocation. Mr. Kneass has given mechanical engineers the best book in existence on the subject on which he has written, and one which should be in the hands of and be studied by every person who is in any way concerned in the use of those invaluable appliances for feeding boilers. It is admirably clear in expounding the principles of these more or less mysterious machines. It is brought up to date in both its theory and practice, and with the exception of some of its engravings it may be commended to all readers who are interested in the subject which it was written to elucidate.

It is our duty to add another word of animadversion, to be administered this time to the publisher. We refer to the quality of the paper. It is made of wood pulp, which breaks on being folded. Before the rising generation have turned their toes upward into a permanently vertical position Mr. Kneass' excellent book—if the whole edition is printed on paper like that in the copy before us—will have passed into the dust of decay, and future generations will lose the light which it could shed on the "state of the art" and of the practice in the use of the appliances which he describes so well.

BOOKS RECEIVED.

THE MEMPHIS BRIDGE. A Report to George H. Nettleton, President of the Kansas City and Memphis Railway & Bridge Company. By George S. Morrison, Chief Engineer of the Memphis Bridge. New York: John Wiley & Sons.

TRADE CATALOGUES.

IN 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

STANDARDS:

For postal-card circulars	3¾ in. × 6½ in.
Pamphlets and trade catalogues	3½ in. × 6 in. 6 in. × 9 in. 9 in. × 12 in.
Specifications and letter paper	8½ in. × 10½ in.

FACTS WORTH KNOWING ABOUT PRESSURE REGULATORS (REDUCING VALVES) AND PUMP GOVERNORS OF PRACTICAL VALUE TO ALL STEAM USERS. By the Foster Engineering Company, Newark, N. J. 40 pp., 4¾ × 6¼ in.

The purpose of this pamphlet is to describe and set forth the advantages of the Foster pressure regulator and its superiority over other devices for doing the same work. It gives very good wood-engravings of the device, with an explanation of its construction, a statement of the weak points of other regulators, and of the advantages of the one which the Foster company make. These are all excellent in their way, but they seem to be arranged in a wrong order. If the description given on pages 14 to 18 had been given first, and the commendation of the Foster regulator and the derogation of others afterward, they would all have been more easy of comprehension. The good points of this regulator are clearly set forth, however, and that is the main purpose of the publication. The Foster Company also make steam gauges and the McDowell inside safety chuck-valve for locomotives, the use of which, or of one equally good, should be compulsory on all locomotives.

THE NORTON IMPROVED BALL-BEARING RATCHET SCREW JACKS. Manufactured by A. O. Norton, Boston, Mass. 20 pp., 5¾ × 7¾ in.

The ball-bearing feature of these jacks is described as follows by the manufacturers: "To the upper end of the screw is fastened a steel gear; a hardened tool-steel plate encircles the hub and rests on the body of the said gear, on which are placed circular trains of hardened steel balls held in place by rings between the rows. In the top or head of the sliding sleeve is placed another hardened tool-steel plate with a hole in the centre, through which the end of the screw projects. When the jack is assembled the sleeve slides down over the screw and standard, the bearing plate in the head resting on the balls on the plate on the gear, so that the whole weight is carried by the balls between the steel plates, which act as a thrust bearing between the screw and head of the sleeve, reducing the friction and increasing the lifting power of the jack."

Various forms of this and also of non-ball-bearing jacks intended for different purposes are illustrated and described, and testimonials are given of their efficiency.

CATALOGUE AND PRICE-LIST OF KEUFFEL & ESSER COMPANY, Manufacturers and Importers of Drawing Materials and Surveying Instruments. 404 pp., 8¾ × 5¼ in.

Probably no better notice of this volume can be given than that which the Keuffel & Esser Company have had written, and which is contained in a letter received with it. In this they say:

"This edition is not a reprint from former ones, but has been rewritten and revised and enlarged by more than 100 pages. While we confine ourselves strictly to our line of business—drawing materials and surveying instruments—we have endeavored to omit nothing in this line which is good and reliable, and our catalogue therefore represents the latest real improvements and progress made since our last edition.

"We also bring a great amount of explanatory matter, such as a short treatise on drawing paper, a valuable explanation about drawing instruments, explanations of planimeters and similar instruments, an exhaustive description of the progress of surveying instruments, an illustrated paper on verniers and their application, colored details of the most improved style of graduating levelling rods, directions for reading elevations by aneroids, explanations about field glasses, etc.

"There are distributed through the catalogue a number of half-tone views (from photographs) of the several departments of our store and factories. These will be of interest also, because they will enable the reader who does not know us to distinguish between our catalogue, to a great extent of special lines and makes, and many other catalogues which are individual only on their title-page and obsolete in their contents."

The half-tone engravings referred to are admirable, but have hardly had justice done them in the printing, as the paper on which they appear is not suited for that kind of work. It is especially to be regretted that the engraving of the beautiful front of their new building has not had full justice done to it.

Probably many an impecunious draftsman will turn green with envy in looking through this book on seeing the many admirable instruments and materials used in his craft, and which are described and illustrated therein. The mere enumeration of these would take much more space than can be devoted to this subject. Those who have occasion to use drawing materials or surveying instruments should send for the book.

THE GOUBERT FEED-WATER HEATER; ALSO ENGINE CONDENSER AND DISTILLING CONDENSER. The Goubert Manufacturing Company, New York. 40 pp., 6 × 9 in.

The manufacturers have here illustrated and described the various forms of apparatus which they are manufacturing, and have indicated their uses and the methods of its application. The illustrations are excellent wood-cuts, and the descriptions

are generally clear and satisfactory, but would have been more so if some letters of reference had been used in the text and in the engravings so as to designate the parts referred to. The criticism we are disposed to make is that the opening pages consist of commendation, and the descriptive matter follows. This is the salesman's method, but even from his point of view it seems to be a mistake, for the reason that to commend anything which a person operated on does not understand has very little effect. The thing to do is to give him a clear idea of the construction and operation of the thing commended, and when once this is lodged in his mind, then is the time to dilate on its merits with the kind of eloquence of which some salesmen are such masters.

In some cases, too, the explanations are inadequate. Thus, on page 8, it is said: "This shell is bolted to the lower water chamber, but is *free to expand independently of the tubes;* its only connection at the top with the upper tube-plate being made by means of a flexible copper gasket." This is followed by a statement of the advantages of this expansion arrangement, and the reader is left to guess as best he can how it is constructed, while the next page contains an excellent sectional view of the expansion joint. If the sentence quoted had been followed by an explanation somewhat as follows: "The connection of the tube-plate to the shell of the heater is shown by a sectional view on page 9; *a a* is the copper gasket which is fastened to the flange *b* of the shell *c* by an annular flange or ring, *d*, and bolt, *e*. The gasket is fastened to the tube-plate and water-chamber by bolts *f*, which pass through a flange on the chamber and through the tube-plate. The annular ring *d* is slightly bevelled at *g* and the tube-plate at *h*, which permits a certain amount of vertical movement of the flexible gasket, which prevents any strain being brought on the tubes or the shell of the heater by the expansion or contraction of either," then, with such a description, the reader would have understood what followed without what may be called a break in his intelligence. The description of the condenser on pages 20 and 21 would have also been much clearer if a sectional view of it had been shown indicating how the water circulated through it.

It will be understood that our criticisms are of the catalogue and not of the heater or condenser, both of which appliances seem to be admirably suited for the purpose for which they are intended. The illustrations and descriptions of the methods of applying them on pages 12 to 21 are admirable. On page 20 it is said that with the arrangement described "the coldest water comes in contact with the hottest steam." The advantages of this might be questioned. If the coldest steam escaped into the exhaust after being in contact with the coldest water, the steam would have given up and the water absorbed more heat than would be the case if the surfaces to which the steam was exposed just before escaping were hotter. In other words, it seems desirable in feed-water heaters and in boilers to keep the coldest water in contact with the coldest heating surfaces and the hottest water in contact with the hottest surfaces.

The description of the condensers is followed by tables, one showing the yearly saving effected by the use of feed-water heaters for various H.P. and at different prices of coal, and another the percentage of fuel saved, both of which are herewith reproduced by special permission. Another table gives the "Equation of Pipes," or the number of pipes of one size required to equal in delivery other larger pipes of same length and under same conditions. Eleven pages are occupied by a list of names of parties who are used as references. On the last two pages an engraving and description of the Stratton separator are given.

TABLE SHOWING THE YEARLY SAVING EFFECTED BY THE USE OF THE FEED-WATER HEATER FOR VARIOUS H.P. AND AT DIFFERENT PRICES OF COAL.

H.P. of Engine.	Coal Consumption at 4 lbs. per H.P. per Hour.		Saving of 13½ Per Cent.	Price of Coal per Ton of 2,240 Lbs.									
	Daily.	Yearly.		$1.50	$2.00	$2.50	$3.00	$3.50	$4.00	$4.50	$5.00	$5.50	$6.00
	Lbs.	Tons.	Tons.										
50	2,000	268	36.18	$54	$72	$90	$108	$126	$145	$163	$181	$199	$217
60	2,400	321	43.33	65	87	108	103	152	173	194	217	238	260
70	2,800	375	50.62	76	101	126	153	177	202	227	253	278	304
80	3,200	429	57.91	87	116	145	174	203	232	261	289	318	347
100	4.000	536	72.36	108	145	187	217	253	289	325	362	398	434
120	4,800	643	86.80	130	174	217	260	304	347	390	434	477	521
160	6,400	857	115.69	173	231	289	347	404	463	520	578	635	694
200	8,000	1,072	144.72	217	289	362	434	506	579	651	724	796	868
250	10,000	1,340	185.90	279	372	465	558	651	744	837	929	1,022	1.115
300	12,000	1,608	226.08	339	452	565	678	791	904	1,017	1,130	1,243	1,356
350	14,000	1,876	253.26	380	506	633	760	886	1,013	1,139	1,266	1,392	1,519
400	16,000	2,144	289.44	434	579	723	868	1,013	1,158	1,302	1,447	1,591	1,730
500	20,000	2,680	361.80	543	724	904	1,085	1,267	1,447	1,627	1,809	1,990	2,170
600	24,000	3,216	433.30	650	867	1,083	1,300	1,517	1,733	1,950	2,170	2,387	2,600
700	28,000	3,752	506.20	759	1,012	1,265	1,518	1,771	2,025	2,278	2,531	2,784	3,087
800	32,000	4,288	579.10	868	1,158	1,448	1,737	2,026	2,316	2,605	2,895	3,184	3,474
900	36,000	4,824	651.24	977	1,302	1,628	1,954	2,279	2,605	2,930	3,256	3 581	3,907
1,000	40,000	5,360	723.60	1,085	1,447	1,809	2,170	2,532	2,894	3,255	3,618	3,990	4,341

PERCENTAGE OF FUEL SAVED BY HEATING FEED-WATER.

(STEAM PRESSURE 60 LBS.)

Initial Temperature of Water Entering Heater.	Heat Units Absorbed in Generating Steam.	Temperature of Water Entering Boiler.												
		120°	140°	160°	180°	200°	202°	204°	206°	208°	210°	212°	214°	216°
32°	1,175	7.49	9.19	10.89	12.59	14.30	14.47	14.64	14.81	14.98	15.15	15.32	15.49	15.66
40°	1,167	6.86	8.57	10.28	12.00	13.71	13.88	14.05	14.22	14.40	14.57	14.74	14.91	15.08
50°	1,157	6.05	7.78	9.51	11.24	12.97	13.14	13.32	13.49	13.66	13.83	14.00	14.18	14.35
60°	1,147	5.23	6.97	8.72	10 46	12.21	12.38	12.55	12.73	12.90	13.08	13.25	13.43	13.60
70°	1,137	4.41	6.16	7.91	9 67	11.43	11.61	11.78	11.96	12.14	12.31	12.49	12 66	12.84
80°	1,127	3.44	5.32	7.10	8.87	10.65	10.82	11.00	11.18	11.36	11.53	11.71	11.89	12 07
90°	1,117	2.68	4.47	6.26	8.06	9.85	10.03	10.21	10.38	10.56	10.74	10.92	11.10	11.28
100°	1,107	1.80	3.61	5.42	7.23	9.03	9.21	9.39	9 57	9.75	9.93	10.11	10 29	10.47
110°	1,097	.91	2.73	4.55	6.38	8.20	8.38	8.56	8.74	8.93	9.11	9.29	9.47	9.66
120°	1,087	....	1.84	3.67	5.51	7.35	7.54	7.77	7.90	8.19	8.27	8.45	8.64	8.82

Recent Air and Gas Compressors. By the Rand Drill Company, New York. 32 pp., 6¾ × 10 in.

The uses of compressed air are extending so rapidly and in

so many different directions that any publication containing information with reference to the machinery and appliances used is now of interest. In the catalogue before us the subject is introduced as follows:

THE COMPRESSION OF AIR IN STAGES.

"As the advantages of this method have come to be understood, the use of compressors in which the work is done in two or more cylinders in succession has increased in popularity. For high-pressure work this process is practically a necessity, and while for the more usual pressures used in mining work the necessity does not exist, it is nevertheless true that considerable economy of fuel is secured by its adoption. The system is analogous to the working of steam through two cylinders in succession, as in a compound engine. The duplex construction of the compressor offers unusual facilities for compounding both steam and air cylinders, and this system of construction is now a marked feature of our work."

Illustrations and descriptions are then given of a duplex compound Corliss compressor, a compound compressor of moderate size, a water-power compressor with a Pelton wheel on the crank shaft, a water-power compressor belted to a turbine wheel, a duplex belt-driven compressor, a small belt-driven compressor, a duplex compressor for natural gas, a straight-line compressor for natural gas, a horizontal three-stage high-pressure compressor, a vertical three-stage high-pressure compressor, a vertical two-stage high-pressure compressor, and finally views are given of an air-lift pump and the pneumatic dynamite gun.

A summary of a report of a test made by one of our contemporaries is given in which it is said that it was shown that an ordinary railroad train brake air pump used 5½ times as much steam as a crank and fly-wheel compressor. If this is so, there seems to be a very great opportunity for improving brake pumps.

The description of the air-lift pump is also interesting. This consists of a vertical water pipe inserted in a well, mine, or other receptacle of water, from which it is to be elevated. This pipe has an open bell mouth at its bottom. Another pipe conveys air to the bottom of the well, where the air is delivered into the bell mouth from a bend of the air pipe. The writer of the pamphlet says: "The natural levity of the air compared with the water causes it to rise, and in rising, to carry the water with it in the form of successive pistons following one another. This system of pumping has found a large range of application, and is of peculiar service in connection with deep-well pumping."

We cannot speak in very high commendation of the engravings of the catalogue, some of which appear to be made from retouched photographs and others from wash drawings. They are weak and feeble, and the printing is not first rate.

Another defect of the catalogue is that it don't explain sufficiently the construction of the compressors which are illustrated. One longs for a view of the insides of the cylinders of the pumps, and every intelligent mechanical engineer would like to know the construction of the valves and their gear when there is any.

ILLUSTRATIONS OF FILES, RASPS AND TOOLS. Issued by the Nicholson File Company, Providence, R. I. 60 pp., 11×14½ in.

A reader of many trade catalogues, which relate to mechanical engineering, has constantly occasion for astonishment at the extent and the variety of the information which is constantly being evolved and formulated concerning what we are sometimes disposed to think are very ordinary matters. Probably most mechanical engineers and machinists think that they know about all that is worth knowing concerning files. If, with this impression, they should take up the catalogue before us they will find in the beginning the statement that this company at their Providence factory alone make over 3,000 different kinds of files, which leads to the inference that there are many with which an ordinary mechanic has no knowledge. Many of these are illustrated in the admirable catalogue just issued by this company. The files are represented by excellent wood-engravings, which the publishers say they have "aimed to have made so accurate as to enable selections to be made as nearly as possible as if the files themselves were represented. The number of teeth shown is practically correct for the lengths of files illustrated."

The first page contains general views of the works and the second interior views of the offices, drawing-room, experimental department, and laboratory. These engravings are made from wash drawings, of which it may be said that they *are* very "washy." An alphabetical index may always be regarded as a means of salvation. The Nicholson Company give a very good one on page 5. A portrait of Mr. William Thomas Nicholson, the founder of the works, with a brief historical account of them, occupies page 6. Page 7 contains a wood-engraving representing the company's exhibit in Chicago, where the number of kinds of files mentioned above were exhibited. On pages 10 and 11 the sections of file steel used for making the regular kinds and sizes are shown. These sections are squares, circles, triangles, parallelograms, segments, trapezoids and other figures of which we don't know the names.

It would take more time and room than we can possibly devote to this review to describe, in the briefest way, the different kinds of files illustrated in this catalogue. These, we are told, are made in the regular grades of cut—"rough, coarse, bastard, second cut, smooth and dead smooth"—but of the peculiar arrangement of the teeth secured to this company by letters patent, and are universally known as the "increment cut files."

Of this peculiarity it is said, further:

"The arrangement of the teeth of the increment cut may be described as follows:

"1. The rows of teeth are spaced progressively wider from the point toward the middle of the file by regular increments of spacing, and progressively narrower from the middle toward the heel by regular decrements of spacing.

"2. This general law of the spacing of the teeth is modified by introducing, as they are cut, an element of controllable irregularity as to their spacing, which irregularity is confined within maximum and minimum limits, but is not a regular progressive increment or decrement.

"3. In arranging the teeth of files so that the successive rows shall not be exactly parallel, but cut slightly angularly with respect to each other, the angle or the inclination being reversed (during the operation of cutting) as necessity requires.

"In addition to the above the tooth is so formed as to have a keen edge and special shape, designed to withstand pressure and to free itself readily from chips.

"Files possessing the characteristics above mentioned do not produce channels or furrows in the work, but effect a shearing cut, for the reason that no two successive teeth in any longitudinal row of a cross-cut file are in alignment; the file is thereby able to cut more smoothly and more rapidly, and possesses greater endurance than any file whose teeth are not disposed upon the same principles."

This explanation, it is thought, might have been amplified to the advantage of the reader, as it is not obvious why the "increment" feature has the effect described. Next, what effect does the "element of controllable irregularity of the spacing" have on the action of the file; and what governs the "maximum and minimum limits"? Then, too, an inquiring mechanic will be disposed to ask what is the "special shape" of the teeth which gives the best results?

These claims are not disputed, only somewhat fuller explanation is desired.

The pages on which the files are illustrated are, many of them, illuminated with views of the works of the washy kind, but which give an excellent idea of them. The volume ends up with descriptions of "manicure" files and "corn knives," which recalls the pathetic line of poetry:

"Tall aches from little toe-corns grow."

Some other special tools, such as machinists' scrapers, bent rifflers, stub-files and holders, file-cleaners, etc., complete the volume, which is admirably printed on excellent paper and bound in limp morocco. It is a little large and unwieldy, which is the price which must be paid for having the products of this company illustreted full size, so as "to enable selections to be made as nearly as possible as if the files themselves were presented."

NOTES AND NEWS.

Patent Office Now Up to Date.—For the first time in 15 years the United States Patent Office finds itself this week up to date with its work. This means that in all of its 33 examining divisions the work is in such a condition that a new application filed to-day will be acted upon on its merits within 30 days, and an amendment filed to-day will receive attention within two weeks. One year and a half ago the more important and busiest branches of the office were more than 10 months behindhand. One year ago 27 divisions were more than a month in arrears; 12 were more than two months, and seven more than three months behindhand. The office force has not been increased, nor has the number of applicants fallen off. The new applications average between 700 and 800 a week, and the number of amendments about 1,600.—*Washington Evening Star.*

Early Locomotives Constructed by R. Stephenson & Co. —Corrections.—Mr. Stretton has called our attention to an annoying error in the table which gives a list of early locomotive engines constructed by R. Stephenson & Co., which was published on page 32 of our January number. Engine No.

106, named *H. Schultz*, was a six-wheeled machine with a bogie and one pair of drivers, and not a four-wheeled engine with cylinders inside, as printed in the table. No. 107, named the *Meteor*, was built for the Boston & Worcester Railroad, and had nothing to do with the Pennsylvania Railroad, as the last column of our table would indicate. No. 107, named *Kentucky*, was a four-wheeled engine with the cylinders inside, and was used on the Pennsylvania Railroad, Philadelphia Division. The error apparently occurred from the printer placing the details in columns six and seven one line too high.

But misfortunes and mistakes never come singly. On page 12 the date when the *Planet* was put to work is given as October 30; it should be October 4. The weight in driving-wheels is given as 8 tons, 2 cwt. 2 qrs. It should be 5 tons, 8 cwt. 2 qrs.

The International Railway Congress.—The members of the International Railway Congress, according to the Glasgow *Herald*, will leave London for Glasgow on July 10 next, and will visit all the principal railway works and centres in Scotland, the excursion forming a termination to the eight days' meetings at the Imperial Institute. The proceedings will begin on the afternoon of June 26, when there will be a ceremonial opening, at which the Prince of Wales is to preside, and then the members will go for three days on excursions to Lancashire and elsewhere, settling down to business on Monday, July 1, and continuing until they start for Scotland. There are to be five sections; and already the reports which are to form the bases of discussion have been prepared, the reporters having been named months ago. In section one an English and an Austrian expert will report on permanent way for high speeds; a French expert on special points in permanent ways; an Italian on junctions; and an Austrian on bridges. In section two a Frenchman will report on boilers; an Englishman on express locomotives; another on express trains, and a Frenchman on electric locomotives, and so on through the other three sections, dealing with traffic, with light railways, and with general questions. There are in all 31 writers of reports—12 English, six French, four Italian, three Austrian, three Belgian, two Russian, and one Roumanian.

An Old, Old Story.—The letter, of which the following reprint is a copy, it will be seen was dated as far back as 1835, and was addressed to Mr. Horatio Allen, who was then an officer of the South Carolina Railroad. The same kind of story has been told thousands of times since then, but perhaps never more graphically than by Mr. Fairy:

Addressed To The Honrl Maj'r Allen of Charleston, S. C.:

State of South caroline Orangeburg District To the rail road and company I have again taken the opertunety of riting to know if you received my letter dated the 11 wich I heir giv you to under stand that your steam carr have killid a Fine young cow for me wich left a calf a few days old wich perished for want of its mother wich cow was kilid the 7 of Febuary also a bout two weaks before this i had a fine sheap yew mashed to death on the road wich left a fine lam wich also perished and died for its motr I asked Mr Roeth his advise about it he told me i shod git two men that knew the cow and value her as if on oath wich men hav said she where worth twenty Dolars the sheep three Dolars also your road have went throo my Land without my leaf I leave it to your chois pay me for my cow and sheap or moove your road round my field you have burnt my fens and i want my fens maid as soon as posibel i lived in peace before your rail road came throo my land you promis to make a bridg in my field wich has not bin don I wish ad answer or my money as soon as possibel Mr Alen

March the 16 1835

John W. Fairy two miles below branchvil.

Wages of Railroad Men—In its last annual report the New York Central gives information as to the average yearly income of different classes of its staff. I quote a few figures:

	Per annum.
Engine drivers	$1,200
Firemen	650
Station-masters	630
Passenger conductors	1,000
Brakemen and baggage masters	630
Clerks in the head office	800
Telegraph clerks	600
Signalmen and switchmen	500
Section foremen	600
Section men	420

We may, no doubt, assume that the New York Central pays as high as any company in the Eastern States, and on this basis it will be evident that when we allow for the different cost of living, for the fact that American railway berths are by no means like ours—a provision for life—and carry with them practically no additional advantages in the shape of pensions and superannuation and accident funds, and so forth, American railway men are not on the average much, if at all, better off than ours. Another point that will strike everybody is the very different graduation of salaries in England and America.

That the average station-master should be paid less than a fireman, less than two-thirds of the wages of a guard, and only a very little more than half the wages of an engine driver, will no doubt strike an English reader as very curious. We must of course, however, remember that while, on the one hand, the American station-master deals only with very few passengers and with still fewer trains in the day, the duties of a driver on railways with no block system and with no fences, working engines habitually loaded up to their maximum capacity, are both immensely more hazardous and vastly more responsible and difficult than is the case in this country.—*Transport.*

A Comparative Test of Water-Tube and "Scotch" Marine Boilers.—The Chicago Ship-Building Company have recently taken a contract for several freight steamers which are to be 405 ft. over all, and of 6,000 tons capacity. One of these is to be supplied with "Scotch" and another with Babcock & Wilcox water-tube boilers. The Chicago Ship-Building Company offered to place these two steamers at the disposal of the United States Bureau of Steam Engineering for test as to the comparative merits of the two types of boilers. This offer has been accepted by Commodore George W. Melville, Chief of the Bureau, who sent the following reply in response to this offer:

Department of the Navy,
Bureau of Steam Engineering,
Washington, D. C., January 31, 1895.

To Chicago Ship Building Company, One Hundred and First Street and Calumet River, Chicago, Ill.:

Gentlemen: The Bureau will be pleased to accept your generous offer, and will endeavor by all means possible to make the test as complete and as comprehensive as possible, in order that there may be no question about the result. The opportunity is an unusual one, the identity of the two steamers, except in boilers, being such as to eliminate many points of contention which have arisen when similar ships have been tried with different types of boilers, but also with modifications in the engines or screws and thus left room for controversy afterward.

The Bureau will be quite ready to co-operate with you later regarding the arrangements for the tests, which it believes will be of great interest in themselves and valuable to the engineering profession generally.

In conclusion, the Bureau wishes to say that this offer of yours is a very generous one and one that is highly appreciated; and the liberality which inspires it can but win the admiration of the engineering world.

G. W. Melville,
Engineer-in-Chief, U. S. N., Chief of Bureau.

These tests, which will be conducted with the thoroughness characteristic of everything done by this Bureau, will be very interesting, and the information which will be gained therefrom will doubtless be very valuable.

Large Gas Engines.—We have from time to time noted the increased sizes of gas engines that are being introduced for various purposes, and it would seem that the great economy that has been developed in their operation of small powers is gradually working its way into the larger machines. The *Portefeuille Economique des Machines* recently published a description of an exceedingly large gas engine that has been built by Messrs. Delamare, Deboutteville & Malandin for the mills of M. Abel Leblanc, near Paris. The engine is a remodelled type of the *Simplex*, and differs somewhat in the details of its construction from the 100-H.P. engines heretofore constructed. In order to appreciate the dimensions of the machine as compared with those that have preceded it, it will suffice to say that from 80 H.P. to 100 H.P. is the most that they have realized, using common illuminating gas. These new engines, however, will develop 450 H.P. with the same gas. In an actual test with low-grade gas, 320 I.H.P. have been obtained. The engine is of the single cylinder type, and it is 34¼ in. in diameter, with a stroke of 39⅜ in., making 100 revolutions per minute. The fuel used is the fine coal from the mines of Anzin. As a brake test with such a large motor would be exceedingly difficult, and as the mill could not be stopped for the purpose, but must be kept running night and day, the test was made under the actual running conditions and this was done in the following manner; Two cars, containing

22,000 lbs. of coal each, were set aside, and the gas generators were filled to the top with the old store of coal and time carefully noted. The mill was loaded according to a predetermined production, and indicator cards were taken at frequent intervals during the test to determine the effort that was being exerted upon the piston. When the two carloads were exhausted, the time of the last filling of the generators was noted, and it was found that the coal had lasted for 194 hours. The cards showed that more than 280 I.H.P. had been developed, and this corresponded to about 220 brake H.P. The computations show, no deductions having been made for ash, that the consumption was about 0.81 lbs. per I.H.P. and 1.03 lbs. per brake H.P. per hour. Three months afterward a second test was made, in which the figures just given were duplicated. These results are so remarkable that they deserve to attract the attention of engineers, electricians and manufacturers, as they are far below the most efficient steam engines that have thus far been constructed.

Compressed Gas for Barge Propulsion.—Compressed gas has been used for some time for the propulsion of small vessels, such as launches and pleasure craft; but recently a company has been formed at Havre for the purpose of establishing a line of barges to ply on the Seine between that point and Paris that are to be propelled by gas engines, and carrying their own supply of compressed gas. The gas is produced at a small gas works situated midway between the two places, where the gas is compressed to a pressure of about 1,400 lbs. per square inch, and is stored in special gas-holders. When the supply of gas on the barge is exhausted it is quickly replenished by connecting it with the pipes leading to the storage tanks. The first barge to be fitted is an iron vessel having a length of 98½ ft., a breadth of 18 ft., and drawing 7 ft. 4½ in. of water. It is divided into four water-tight compartments, in the forward one of which are located the quarters of the captain and the crew. The cargo is carried in the two central compartments, while the engine is placed in the stern. The gross tonnage of the vessel is 300, but the quarters of the crew and the space occupied by the engine are so small that a cargo of 250 tons can be carried. The gas is stored in steel tubes having an outside diameter of 9.84 in. and a thickness of 3.1 in. and a length of 16.4 ft. Each tube weighs 715 lbs. and will hold 777 cub. ft. of gas at a pressure of 1,400 lbs. per square inch. They were, however, tested at a pressure of 2,250 lbs. There are 80 of these tubes, and they are connected to each other by flexible tubes, the joints of which have been tested to the same pressure as the tubes themselves. In order to prevent accidents and economize space they have been placed on the captain's bridge, so that should any leakage occur there can be no danger, as the gas will escape directly into the atmosphere. The gas is expanded down to the desired pressure for the engine by a special apparatus. The engine is of the vertical two-cylinder type of about 40 H.P., with the cranks set at right angles. On one end of the shaft there is a fly-wheel used for starting the engine. The vessel is equipped with a two bladed reversible propeller by means of which different directions or speeds may be given to the boat without stopping or reversing the engine. On the occasion of a trial trip, when the vessel was loaded with 80 tons, a speed of about 6½ miles per hour was attained with the engine running at 200 revolutions per minute, and the propeller worked well both ahead and astern, and stopped without affecting the engine in any way.

The Atlanta Exposition.—The interest felt in the exposition that is to be held at Atlanta, Ga., during the coming fall is growing, especially in the South. State exhibits will form a very important feature of the exposition. At first they seemed tardy, but of late a number of States have taken active interest in the Exposition, and some at a distance seem as much enlisted as those adjoining Georgia. Georgia, Florida, Alabama, North Carolina, Louisiana, Arkansas, Illinois and New Mexico is the list up to date. Some of these have not taken definite action; but it is probable that all of them will be represented, and others are expected to come in. The great railroad corporations of the South will have an important part in the Exposition. The Southern Railway will erect a building of its own near the entrance. The Plant system, of Georgia and Florida, with steamer connections in the West Indies, will be handsomely represented. Colonel D. H. Elliott, Land Commissioner of this system, who has the exhibit in charge, writes that it will take the form of a pyramid 100 ft. square at the base and 50 ft. high. The Flagler system, of Florida, will be handsomely represented at the Exposition, and Mr. J. E. Ingraham, its representative, has been appointed by Governor Mitchell as Commissioner for the State exhibit. Colonel W. D. Chipley, who represents the Louisville & Nashville system in Florida, with headquarters at Pensacola, is Assistant Commissioner, and has already applied for large space for a West Florida exhibit to cover ten counties in the hill country between Tallahassee and Pensacola. Paraguay was the last foreign country to announce an exhibit at this exposition. The list now includes Mexico, Venezuela, Honduras, Nicaragua, the Argentine Republic, Paraguay, Italy, Austria-Hungary and probably Greece. The exhibits from Italy and Austria Hungary will be secured by special commissioners, who performed the same service for the World's Fair. Italy will cover 10,000 sq. ft. and Austria-Hungary 5,000 sq. ft. In the same way it is proposed to secure exhibits from England, Germany, France and Belgium, covering about 15,000 sq. ft. So far applications for space have been received from Canada, England, Switzerland, France, Japan and Tasmania. Great activity is shown among the textile industries of England, particularly at Bradford, the seat of the woollen industry. This exposition will not be without picturesque features. There will be a Mexican village, a Guatemalan village, an Oriental village, and probably a Japanese garden. The last mentioned will be one of the most unique and beautiful features of the fair.

The Water Level in the Lakes.—The probable effect of the opening of the Chicago drainage canal upon the water level of the great lakes has been the subject of discussion ever since that tremendous project took shape. A cry of alarm was raised several years ago when it was announced that the diversion of water from Lake Michigan in anything like the quantity required to fill the canal then being constructed across Illinois to the Mississippi Valley would seriously interfere with the navigation of the St. Clair and Detroit rivers, and render it impossible for heavy draft vessels to enter most of the harbors on the lower lakes. The Chicago engineers have done their best ever since to dispel that belief. They have maintained that the taking from the lakes of all the water that will ever be required for the canal will not lower the lake level more than 3 in., and the Chicago newspapers have all endorsed the opinions expressed by the Chicago engineers, as a matter of course.

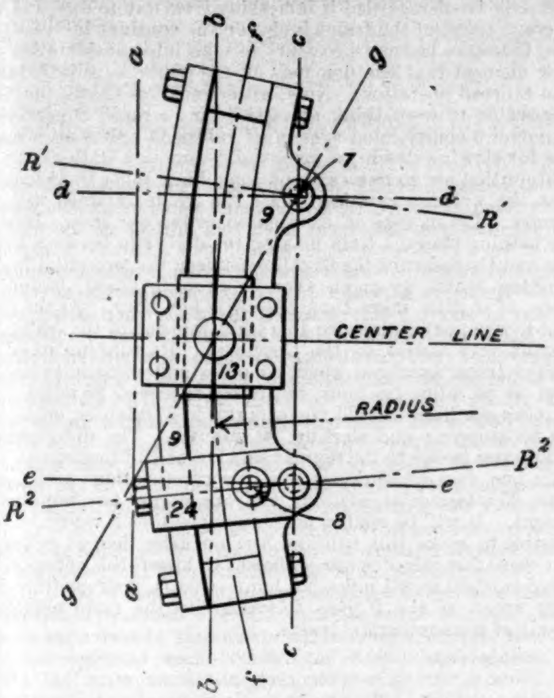
Professor G. Frederick Wright, of Oberlin College, who has perhaps made a more careful study of the geology and geography of the lake region than any other man in the United States, does not agree with the Chicago engineers, however. Professor Wright shows that the quantity of water required to be turned into the drainage canal when it is first opened will be equal to about 5 per cent. of the quantity that now flows over Niagara. When the population of Chicago reaches 2,000,000 the law under which the canal was constructed provides that the quantity of water passing through it shall be doubled. That means that at least 10 per cent. as much water as now passes over Niagara will be diverted from the lakes to the Mississippi. Major Ruffner, of the Corps of Engineers of the United States Army, estimates that when the drainage canal is first opened the result will be to lower the level of Lakes Michigan, Huron and Erie and the connecting rivers at least 9 in., and that when the canal is operated to its full capacity the fall in the water level will be 18 in. This, Professor Wright says, may have but little effect in the rainy season, but during the late summer and autumn he is certain that it will seriously interfere with navigation. He declares that the vessel owners and all who are interested in the commerce of the lakes should realize the danger and do all they can to avert it. As a preventive measure he suggests that a dam be constructed across the lower end of Lake Superior at the "Soo," which will raise the level of that lake 2 ft. and store enough water during the rainy season to supply the lower lakes during the late summer and fall.—*Cleveland Leader.*

WARREN'S IMPROVED LINK.

Editor of THE AMERICAN ENGINEER AND RAILROAD JOURNAL:

I noticed in the AMERICAN ENGINEER for December a description of the improvement in the link motion patented by me, and which does not describe clearly the advantages of the invention and the claims of the patent. As you will please notice, I have reserved the right to change the location of the eccentric-rod coupling-pin holes in a horizontal direction to correct any point of cut off, and still retain the eccentric-rod couplings at unequal distances from the centre of the main shaft. Referring to the figure herewith, which is a side view of a skeleton link, of which the saddle-pin 13 is on the centre line of the link, and the eccentric-rod coupling-pin hole 7 is located 3 in. from the centre line *f f*, or in the usual position on ordinary links. The eccentric-rod coupling pin 8 is located ½ in. from the centre line *f f*. Both are on radial lines $R^1 R^1$ and $R^2 R^2$. You will notice that the eccentric coupling-pin 8

is made with a saddle connection, 24. On no two link motions of different design will the location of the eccentric-rod coupling-pins 7 and 8 come alike, and therefore the saddle 24 is left adjustable until the proper location is found, and it is then bolted permanently to the link. On ordinary link motions with main rods from 7 ft. to 7 ft. 6 in. and eccentric-rods 4 ft. 6 in. to 5 ft. 8 in. and links from 11 in. to 13 in. long, the location of the pin 8 will range from ¼ in. to 1¼ in. from the centre line *f f*, and the position of the pin 7 will vary from 2¾ in. to 3 in. from the centre line *f f* in order that the valve will cut off equally for each end of the cylinder in the forward motion,



WARREN'S IMPROVED LINK.

tion, and at the same time the valve will cut off accurately in relation to an equal travel of the driving-wheel on the rail when the gear is in the back motion, and which thus gives a very good working engine. I have it applied on a few locomotives here on this line (the Toledo, Peoria & Western Railway), and it has been doing good work for some time past. It is found to save three-fifths of the usual slip of the link on the block on those engines I have tested, and it is immaterial which eccentric-rod coupling is used for the forward motion, but I prefer to use the lower pin for the forward motion.

W. B. WARREN,
General Foreman T. P. & W. R. R. Shops, Peoria, Ill.

WATER HAMMER.

Editor of THE AMERICAN ENGINEER AND RAILROAD JOURNAL:

Can you or any of your readers tell me how to prevent water hammer in steam pipes? I am a resident in an apartment house in New York, which was built 10 or 15 years ago, and consequently the steam fittings are not of the latest or most approved form or design. In the morning, an hour or more before it is time to get up, just when I am having that last nap which is most enjoyable, the —— steam pipes, or rather the water in them, begins to hammer. If a boiler-maker was let loose in my room he could not make a more disagreeable and disturbing noise than the steam pipes emit. Being of a nervous temperament, this wakes me up so effectually and results in so much profane thinking that sleep is impossible thereafter. The company which put the steam fittings in the house have been consulted without avail, the night engineer has been bribed (tell this not to the Lexow Committee), the agent of the building anathematized, but the hammering and its consequent profanity still continues. That steam pipes can be arranged so that there will not be any hammer is, of course, well known; but those in my rooms are not so arranged. What I want to know is how the water hammer can be prevented in the pipes as they now are. If any of your readers can inform the writer how this disturbance can be prevented, my imprecations will be changed to blessings which will be invoked on the person or persons who will prescribe a cure for the present annoyance.

X. Y. Z.

NEW YORK, December 19, 1894.

THE EFFICIENCY OF THE JOHNSTONE COMPOUND LOCOMOTIVE.

Editor of THE AMERICAN ENGINEER AND RAILROAD JOURNAL:

I see by your paper for this month a very interesting article on the performance of the Webb compound and simple engines, as compared with the Buchanan express engine, and in reply to your call for some of us compound men to show what our engines are doing, I herewith hand you statement of performance of six heavy freight engines, embracing three years of actual service, as compared with 17 simple engines of equal capacity and in the same service, embracing a period of four years' actual service.

These engines were in service upon the Mexican Central Railroad, working on a division with 1½ per cent. maximum grades.

A statement, showing the performance of these six compounds and 17 bogies for a period of more than three years, shows the average trains of the compounds, in cars and their contents, to be 216 tons; that of the simple engines, 207½ tons.

The rating of these engines is 440 tons on 1½ per cent. grade, therefore the average train was less than one-half the capacity of the engines. This is due to the fact that the business is pretty much all in one direction, going south into Mexico, while the trains out of the city run light.

We find that the compounds use 79.2 lbs. of coal, and the simple engines 98.1 lbs. per train mile. In comparing this performance on coal with that made upon other roads, a number of circumstances should be considered. As shown above, the trains only average one-half the capacity of the engine, and as there is only one coal mine in Mexico with a limited output, this road is obliged to get their supply of coal from the United States and from Europe. Owing to strikes in the United States and delay to imports from Europe, we are often obliged to get coal from a number of different places, and during the last three years these engines have been obliged to burn more than 12 different kinds of coal, varying in quality from *briquetts* of pressed fuel from England, which has high steaming qualities, down to inferior grades of coal, which we were forced to use under the circumstances, the quantities of these different coals varying from 5 per cent. to 25 per cent. of the total quantities used by the locomotives.

Under these conditions the most skilful firemen cannot produce the best results when obliged to change frequently from one class of coal to another.

Under these conditions the consumption of coal per ton-mile of cars and their contents shows 5.856 oz. for the compounds and 7.520 oz. for the simple engines. This performance of course includes raising steam, switching at all stations, laying on side tracks waiting to make meeting points, and is the performance of engines not always in first-class condition, as it embraces a train mileage of 667,110 miles for the compounds and 2,251,548 miles for the simple engines.

I do not think any comparison can be made between such tests as these and the little teaspoon test, embracing less than 100 miles on comparatively level track, shown in the statement in your issue of December, 1894.

I would call your attention to a series of tests made by Mr. D. L. Barnes with one of my compounds in 1892, after the engine had been in constant service for seven months. These tests embrace a train mileage of 1,180 miles in actual service, tests being made with trains coming south from San Juan del Rio to Mexico, trains approaching in weight to the rating of the engines.

With Colorado soft coal the performance of these engines on this division, with 1½ per cent. maximum grades, shows a consumption of coal varying from 3.36 oz. to 3.82 oz., or an average of 3.56 oz. per ton-mile of cars and contents.

With English patent fuel the performance varied from 3.07 oz. to 3.87 oz., or an average of 3.37 oz.

Now, to show the difficulty of comparing the performance of engines working on 1½ per cent. grades with those working on divisions of track with, say, ½ per cent. grades, let us take the following figures:

For divisions with maximum ½ per cent. grades, these compounds are rated at 1,085 tons of cars and contents, and considering that these engines were worked as hard over such a division as they had to work between San Juan del Rio and Mexico over maximum 1½ per cent. grades, and taking their worst performance on Colorado soft coal, which was 94.1 lbs. per train-mile as the consumption, the performance would be 1.387 oz. per ton-mile of train and contents.

Again, if we compared the performance of these engines with engines running on practically level track, as was the case in the tests of the Webb and Buchanan engines, the figures will stand as follows:

Engines rated at 2,600 tons and allowed 94.1 lbs. of coal per train-mile, we would have a performance of 0.579 oz. per ton-mile of cars and contents.

I think these deductions are not unreasonable, as in all cases where small special tests are made care is taken to have the weight of train approximate the rating of the engine, the best coal is selected, the most skilful men are put in charge of the machine, the engines are in first-class condition, and the tests are invariably made on through runs, where little or no switching is done and long delays at meeting points are avoided as much as possible. Under such conditions, on comparatively level track, I am satisfied my compounds would show a performance of less than 1 oz. per ton-mile of cars and contents.

Yours very truly,
F. W. Johnstone,
Supt. M. P. & M.

PERFORMANCE OF SIX COMPOUND AND SEVENTEEN SIMPLE ENGINES ON THE MEXICAN CENTRAL RAILWAY, SHOWING MORE THAN THREE YEARS' WORK IN REGULAR FREIGHT SERVICE.

	Six Johnstone six-coupled compound freight engines, in service from Oct. 1, 1890, to Nov. 1, 1894 — 37 months. For dimensions, see pamphlet.	17 bogie engines. 20× 24 in. cylinders, 49 in. drivers, 103,000 lbs. on six drivers, in freight service from Oct. 1, 1890, to Nov. 1, 1894—49 months.
Weight of locomotive and tender in working order.	97 tons of 2,000 lbs.	97½ tons of 2,000 lbs.
Average weight of trains in cars and contents...	216 tons of 2,000 lbs.	207½ tons of 2,000 lbs.
Ratio of weight of locomotive and tender to weight of cars and contents....	1.00 to 2.22.	1.00 to 2.12
Total train miles....	667,110	2,251,548
Average speed (actual running time)....	20 miles per hour.	20 miles per hour.
Consumption of coal per mile run, including raising steam	79.2 lbs.	98.1 lbs.
Consumption of coal per per ton mile of cars and contents, exclusive of locomotive and tender, including raising steam, switching at stations, and waiting at meeting points	5.856 oz.	7.520 oz.

[To those of our readers who are not familiar with the construction of the Johnstone type of compound locomotive, it may be said that it possesses the radical difference from all others that have been built, in that its compound feature consists in the use of a large cylinder upon each side of the engine, which serves as the low-pressure cylinder, and that the high-pressure cylinder is enclosed within it. Thus the low-pressure cylinder is actually annular in form. There are three piston-rods for each side, all attached to the same cross-head; two take hold of the low-pressure piston at the top and bottom respectively, and the other is attached to the high-pressure piston. The locomotive is therefore a four-cylinder compound, with only one cylinder apparent on the outside. The following are the general dimensions of the engine referred to in Mr. Johnstone's letter.—Ed.]

Weight on back driving-wheel	36,000 lbs.
" " centre "	36,100 lbs.
" " front "	31,820 lbs.
" " " truck	29,320 lbs.
Total	133,280 lbs.
Diameter of cylinders	13¾ in. and 29½ in.
Stroke of pistons	24 in.
Centre to centre of cylinders	85 in.
Out to out of frames	48 in.
Type of boiler	Belpaire.
Size of firebox	120 in. × 41 in.
Length of tubes (in to in of tube sheets)	12 ft. 10¾ in.
Diameter of tubes, outside	2 in.
Number of tubes	278
Centres of tubes	2¾ in.
Grate area	27.3 sq. ft.
Heating surface, tubes (outside)	1,800 sq. ft.
" " firebox	204 sq. ft.
" " total	2,004 sq. ft.
Thickness of boiler sheets (barrel)	⅝ in.
Travel of valves to H.P. cylinder	5½ in.
" " " " L.P. "	4½ in.
Tractive force per pound of E. P. per sq. in.	81.91 high-pressure cylinder, 371.3 low " "
Date when built	1891
Diameter of driving-wheels	56 in.

YARD ARRANGEMENTS ALONG HEAVY-TRAFFIC HIGH SPEED RAILROADS.*

By A. Flamache.

The arrangements that have been thus far adopted for the yards of intermediate stations and junction points have been planned in a way that is very favorable to the local operation of the station; but sufficient attention has not been paid either to the importance of the traffic on the branches or the intensity of the through traffic. High-speed traffic that could formerly be disregarded is increasing from day to day, and the average speed of the trains is also on the constant increase. It has, therefore become necessary to take into consideration the new element that the demands of the public have introduced into railroad operation. Now, experience has shown that it is impossible to even think of establishing a rapid communication over a complicated system of railroads unless all necessities for slowing down are removed. Junction stations, drawbridges that are so numerous on some lines, must be so located that the average running speed can be maintained without danger. Let us take an example to prove our case. During the bathing season a train making the daily run between Brussels and Ostend runs the 65 miles between the two cities in 104 minutes, which gives an average running speed, including stops, of a little more than 43¼ miles per hour. At the time that it was put into service this train was one of the fastest, if not the very fastest, on the Continent. Its running speed on a clear track averaged about 52 miles and sometimes rose as high as 56 miles per hour, but rarely exceeded 62 miles. At 52 miles per hour it could make its run in 87 minutes, or, allowing for stopping and starting, 90 minutes. The difference of 14 minutes is due to the regular slowing at 12 junctions on the main line, two drawbridges, six important stations with junctions, 25 intermediate stations, and one stop of two minutes at Bruges. It will be readily acknowledged that it would be impossible to make this run and lose no more than 14 minutes. But these few minutes are sufficient to lower the commercial speed from 52 to 43¼ miles per hour—that is, it drops from the high speed of the *Flying Dutchman* to the more moderate speeds of the continental trains.

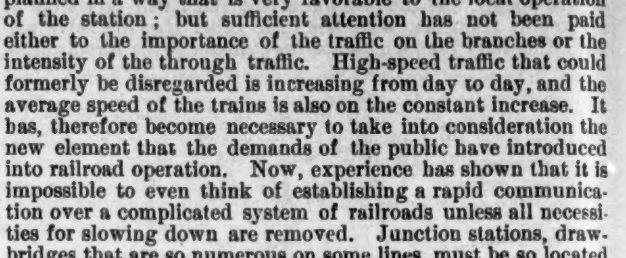


Fig. 1.

This single example serves to show the important effect that slowing-down points have on the commercial speed of trains and the absolute necessity of doing away with them if it is considered desirable to increase the speed of through and interurban trains. I will occupy myself solely with the *possibility* of running fast trains; but the question of *safety* is one that will continually arise. To pass through stations where the main line is occupied for a greater portion of the day at anything more than half speed except when there is a special announcement of the fast train is a genuine case of imprudence. Statistics show that, since the general adoption of interlocking apparatus, collisions at junction points have almost entirely disappeared, that the collisions out on the line have been diminished by 90 per cent., and that now 95 per cent. of the accidents that happen take place at way stations. But speed and safety can only be insured by avoiding all interruptions of the main line at the principal stations and by affording to slow trains that are followed by fast ones a chance to get quickly off from the main line. The object of this note is to examine into the best methods of accomplishing this from the standpoint of the arrangement of station yards.

In the following study I have had the lines of the Belgian State Railway especially in my mind, where the following conditions are met with in a high degree, to wit: a complicated system with a crowded local traffic and traversed by high-speed international trains. We can say in regard to the important stations that they can be considered as the literal counterpart of the general average of such points, where the main lines are considered as the arteries into which the local services flow and upon which they make their connections. It would seem that there is no disadvantage in thus occupying them. At some stations switching is carried on all of the day; at others the junction points of the branch lines are made at some distance from the entrance to the freight yard, and are situated on the

* Bulletin de la Commission Internationale du Congrès des Chemins de fer.

same side, so that a long freight train can be handled and occupy only a small portion of the main line while the work is being done, as shown in fig. 1.

I cannot end my criticisms without saying that the conditions most favorable for high speeds are exactly those that are diametrically opposed to what is most generally adopted. Doubtless the disadvantages that exist have been seen by many engineers. Isolated attempts have been made to improve them, but as they lacked continuity of effort the results have been fruitless. That is why I have considered it advisable to prosecute this work with the idea of bringing out what has been done on foreign roads as well as our own; the arrangements that have been adopted in England acting as a special inspiration.

What are the station arrangements, that, while permitting the local work to be prosecuted without interruption and with the greatest ease, will, at the same time, be most favorable to through traffic?

I have not given examples that can be found in any technical publications, the teachings of which it is difficult to discern. I have, rather, dissected those plans that have been recognized as the best in order to discover their fundamental parts and describe them, leaving to the engineer to group them and make the application to the particular cases that may arise for his solution.

Experience has taught me that there is frequently a great deal of difficulty in making an application of arrangements to a given situation that would be recognized as good in others. Furthermore, I would beg the reader not to attach himself too closely to arrangements that are made for a purely local traffic; for, while the strictest possible attention should be paid to the principles that will be laid down for the traffic of a main line, there are some local arrangements that should be viewed purely from the standpoint of the special needs of the station work. In my opinion, a great deal of latitude should be allowed in this respect as to the number of side tracks, their connections with each other, and the uses to which they are to be put. The general principle from which the least possible variation should be made in the arrangement of stations located along the main line of a heavy-traffic road is the following:

The main tracks should be considered as the exclusive domain of the trains in transit. Trains should be prohibited from standing on these tracks; they should not be crossed, and the local service and switching should be conducted independently of them.

On the other hand, the arrangements should, first of all, yield to the service of the high-speed trains. Consequently:

1. The contour and profile should be as straight and level as possible from one end of the yard to the other. The changes in curvature and gradients should be limited to that which is absolutely necessary. For no reason whatever should the radius of the curves be allowed to drop below that which is permissible for the open lines where the highest speed is maintained. All switch connections should be trailing, unless such an arrangement introduces sags or changes in the level of the main line.

2. The number of switch stands, signals, crossings, frogs and points should be as small as comports with the necessary connections of the local tracks. These constitute not only causes of shocks by breaking the continuity of the rails, but afford means of access whereby obstructions can get upon the main line.

3. The distance included between the extreme limits of the yard should be made as short as possible, in order to increase the length of the main line where the normal speed can be maintained.

4. The local service should not require, except in cases beyond control, that the main line should be crossed. As far as possible all of the local tracks or sidings should be on one side of the main line. When it is to be crossed, bridges or underground passages should be used. The side-tracking of trains, either by backing in or running in head-on should not require the crossing of the main line.

5. The whole extent of the yard, from one limit to the other, should be free and clear of every change and obstruction so as not to introduce intermediate signals, whereby the driver will be compelled to run with the train under control.

6. The connection of the sidings with the main line should be so laid out that the latter can be cleared in the shortest possible time. Every train that stops on the main line constitutes an obstruction, and its presence there is troublesome.

Under these diverse conditions, there are some points that are difficult to harmonize. Thus one could only separate the local service on the two sides of the main line, when they had very slight relationships with each other. We will cite an example of this further on. But, I repeat, that these are general principles that ought to be observed as far as possible, especially the fourth, which I consider to be the most important of the lot. The considerations that will follow will show how they can be applied to concrete examples.

(TO BE CONTINUED.)

MEETING OF MECHANICAL ENGINEERS.

THE ELECTRIC MOTOR IN THE MACHINE SHOP.

THE second of the series of meetings arranged for mechanical engineers was held at the house of the American Society of Mechanical Engineers, No. 12 West Thirty-first Street, New York City, on Wednesday evening, February 13. Mr. Henry R. Towne presided, and the subject for the evening was that given in our headlines. The opening paper was read by Mr. George Richmond, of the De La Vergne Refrigerating Machine Company, and was as follows:

Your committee in charge of these monthly meetings has asked me to introduce for discussion the subject announced for this evening—namely, that of the Electric Motor in the Machine Shop.

I must disclaim at once any special fitness for this duty; and the apology which your committee has been kind enough to furnish for me that in my connection with the De La Vergne Refrigerator Machine Company I have had an opportunity of studying this question would have more force if I could assure you that I had availed myself of this opportunity, which I have not. Even if the contrary were true, you must remember that this installation at the De La Vergne Company was made in 1892, and at the rate at which electrical engineering proceeds, it is now ancient history, and I should be almost ashamed to put forward three-year-old fossils.

But it is the privilege, if not the universal attribute of ignorance to be unprejudiced. Not only have I no axe to grind, but I am absolutely without any strong convictions on the subject. On the contrary, I expect to get, if not religion, at least electricity this evening; for nowadays electricity is almost a religion, and it requires some courage to acknowledge one's self an agnostic.

The present state of the art may be very briefly presented, and for this purpose it is not necessary to consider the subject of electrical transmission in general. The possibilities of long-distance transmission are no longer in question. The relative economy in comparison with other methods of transmitting power may be considered as still an unsettled question, although the extreme simplicity of the electrical methods will undoubtedly have a preponderating influence.

A very great advantage has been found in the substitution of motors for local steam engines in such places as rolling-mills, dockyards, etc., and this was altogether to be expected. Some interesting data in this connection are contained in a paper read by D. Selby-Bigge before a meeting of the Iron & Steel Institute, an abstract of which is to be found in the *Engineering Magazine* for December. He gives as an example of the economy effected, a case where six steam engines, aggregating 94 H.P., were replaced by motors aggregating 29¾ H.P. While it may be said that such figures prove too much, they unquestionably show that there are many cases where extravagant waste of power occurs in transmission; and if the advocates of other systems have slept upon their rights, it is perfectly just that electricity should step in and claim all the glory. Nevertheless, it would be interesting to compare with a so easily won victory some other solution of the problem—say, for example, that of the gas engine operated with producer gas—for it is well known that gas engines do not fall off in economy with such frightful rapidity with decreasing size as do steam engines, and, moreover, the losses in transmission through pipes is trifling compared to that of steam.

Leaving out of consideration the substitution of motors for steam engines, there remain three forms of application of the principle of special interest to the mechanical engineer—namely:

1. The driving of isolated tools where convenience is a chief consideration.

2. The grouping of a number of machines around a motor admitting of an infinite number of combinations—from that of two or three machines to that of all those on the same floor or in the same shop.

3. The building-in of a motor as a part and parcel of each and every machine tool.

There are a number of examples in this country of the first method, among the best known of which are those of Fraser & Chalmers and the De La Vergne Refrigerating Machine Company. Probably many present have seen the arrangements in the latter case for driving the heavy tools in the erecting shop.

The full advantage of direct coupling could not of course be obtained in this case, but the necessary countershafting is attached to the walls of the building, well out of the range of action of the travelling crane. There are in all nine motors of the C. & C. type, including three for the Morgan crane. The aggregate capacity is 75 H.P. It is found by experience that a single 40 H.P. dynamo is sufficient to supply these motors, although it is rather severely taxed when the crane is being operated at the same time that the planing machine is running on a short cut. The average H.P. supplied by the driving engine during a test extending over six weeks was 24 H.P. As this engine was of 100 H.P., so chosen in view of possible extensions, we may deduct 10 H.P. for friction, leaving an average of 14 H.P. supplied to the dynamo. If there are still any advocates of the storage battery, such a case as this presents an opportunity of figuring on the economy of running this whole plant with, say, a 20-H.P. engine in combination with storage batteries.

With regard to the second method, we have much more valuable data in connection with the installation at Herstal, Belgium. In this case we have the advantage of the deliberate choice, based on a careful scientific inquiry and the carrying out of the plan, without any of the compromises necessary in plants already running. A reprint of two important papers, the one by Leon Castermans, Managing Director of the Government Rifle Factory at Herstal, and the other by Felix Melotte, Engineer for the International Company of Electricity, which supplied the electric plant, has been made by the C. & C. Company, and should be in the hands of every one interested in the subject. It is hardly necessary to say that both these gentlemen are enthusiastic advocates of the system adopted; and since they have between them enumerated pretty nearly all the advantages of the same, I cannot do better than read these as propositions for the consideration of the members of this Society. Mr. Castermans, with the ardor of a proselyte, is willing to venture on debatable ground and somewhat broad generalizations. His statement of the advantages is as follows:

1. By the simplicity of its parts, the security against interruption is greater than in other mechanical systems.

2. The elimination of belts, cables, pulleys, countershafts, etc., diminishes enormously the chances of accident or interruption.

3. This system is the only one which will give accurate figures as regards power transmitted and delivered.

4. This system it is which presents the smallest disproportion between effective work and the passive resistance of the transmitting device, and which consequently gives the highest average efficiency.

5. The quantity of masses in movement is less than in any other system.

6. Electrical transmission is especially advantageous from the point of view of future enlargements in a factory. In fact, as each of the motors takes its power directly from the main motive power, it is always possible to put in new motors without affecting the original installation.

7. From the point of view of interior service, it is the only system which offers the possibility of easily disconnecting each transmitting shaft, and, what is more, of varying the speed of each of the elements independently of the others, which can continue to run at their normal speed; this last point offers one of the greatest advantages in a factory.

8. Finally, when the machinery is started up this can be done without shock, electrical transmission operating as a veritable elastic buffer. In the same way, if the work calls for a sudden increase in power, the demand is communicated directly to the steam engine without affecting the speeds of the other machinery, while under the same conditions with a mechanical transmission a shock is produced which is felt throughout the whole system and affects the speed of all the various masses in movement. He mentions other advantages which to the practical man would seem of even greater importance than the foregoing. Transmitting shafts need no longer be absolutely parallel; they can even be put in all directions; and this permits of laying out the plan for the workshops, taking only into consideration good conditions of manufacture, without having to consider in advance the position which shall be given to the shafting.

Mr. Melotte supplies a most interesting study, for the technical details.

His statement as to the advantages is as follows:

1. It assures the complete independence of each main shaft.

2. It permits the stopping of one shaft without stopping the whole factory and without having to use devices which are expensive and which are always difficult to arrange for.

3. It permits of throwing a shaft which has been stopped, in again, which is not the case with most devices.

4. It permits of overloads as easily as any other system; thus the motor No. 5 in the Great Hall at the Herstal factory, the normal output of which is 16 H.P., ran for several days at 30 H.P. without inconvenience.

5. It gives more security, should there be a hitch in the transmission, for the motors are provided with an apparatus which cuts out the current automatically when the load runs above the limit. It permits of placing shafts in all the possible positions, without having to bother about making correspondence with those already up.

6. It is less cumbersome. The motor can be put in a corner; the conducting wires will follow the ceilings or the walls, or are carried underground, while mechanical transmissions take up considerable space with their shafts, bearings, pulleys and cables, and require a considerable outlay in repairs and oil.

7. It adapts itself with remarkable facility to any increase in the plant; two pieces of wire and the motor and all is done.

The installation at Herstal consisted of nine 16 H.P. motors, two 37-H.P. motors, and five motors varying from 21 H.P. to 3 H.P. Each of these, with the exception of two, one of which drove a pump and the other a ventilator, drove a line of shafting. The guaranteed efficiencies were 90 per cent. for the dynamo, 98 per cent. for the conductors, and an average of 87 per cent for the motors, giving a total efficiency of 76.6 per cent at the motor. While it may be perfectly true that in the particular case at Herstal this efficiency is superior to that which any one was willing to guarantee for mechanical transmission, it is obvious that it is inferior to the recorded efficiencies in some American machine shops. Professor Flather, in his work on "Dynamometers and Measurement of Power," gives a list of shops in which the per cent. lost in driving the shafting ranges from 15 to 50 per cent., leaving out an exceptional case of 80 per cent. It must be remembered that in comparing these shops with the Herstal factory the friction of the shafts driven by the motors is still to be accounted for in the latter.

It will be observed that many of the advantages enumerated by Messrs. Castermans and Melotte apply with even greater force to the third system—namely, that of the motor coupled directly to each tool. To these may be added the absence of overhead belting, unobstructed light and absolute independence of each machine.

On the other hand, by the multiplication of small motors the efficiency will be considerably reduced and the caretaking increased. So far as is known there is no machine shop equipped in this manner, unless, perhaps, that of the Crocker-Wheeler Company. A very near approach to it, however, so far as division of power is concerned, is to be found in the silk factory of Messrs. J. Forrest & Co., of St. Étienne, France, the description of which appeared in THE AMERICAN ENGINEER for December of last year. Here are employed 60 motors of 25 kilogrammetres, say $\frac{1}{3}$ of a H.P., having an efficiency of 55 per cent., driving ribbon and velvet looms by cord transmission. There are also forty 75-kilogrammetre motors, each driving a loom by belt transmission. In addition to these there are five motors of power varying from 1 H.P. to 3 H.P., and two small motors from 10 to 25 kilogrammetres. The results at St. Étienne seem to be entirely satisfactory. It is obvious that the ultimate solution of the problem is a direct-coupled motor, although the first cost and the fear of an excessive amount of care taking stand in the way of its adoption.

It would seem that the advocates of electrical transmission have exercised themselves to prove a proposition somewhat doubtful in itself and of extremely small importance when taken in connection with the machine shop. Relative economy has a certain importance when power is used to drive machinery of unvarying productive capacity, such as looms, etc., or automatic machinery in general. In this case the workman must be educated to go at the pace set by the machine. In a machine shop, on the other hand, the amount of work of the same kind and quality turned out by different men varies very considerably. After all, the question which the engineer will ask is, Will electrical transmission enable me to turn out work at less cost? If each present will make a mental calculation of the ratio between the total amount paid in wages, interest, and depreciation on machinery, and the amount paid for motive power in his own factory, I think he will find that the motive power is not much more than 1 per cent. of the wages, etc. If it could be proved that the adoption of electrical transmission would increase the production of each man 1 per cent. only, this would compensate for doubling up the cost for motive power. On the other hand, if the introduction of electrical transmission would involve a loss of only 1 per cent. in the efficiency of the workman and machine, it is frivolous to insist upon the relative advantage of a difference between a transmission efficiency of 10 or 20 per cent., since there is an absolute loss equal to the total cost for motive power.

What shall it profit a man though he gain all these advantages enumerated, real and imaginary, and lose the sale of one machine because he cannot produce it cheaply enough?

DISCUSSION.

Professor Crocker: There is a great deal of difficulty in getting exact figures regarding this question, because so much depends on the particular conditions of each case, and any one who expects to get them will be disappointed. Then, too, even supposing that exact figures were available, there is another element that must be taken into consideration; it is as to whether the superintendent and workmen like the system, and this is one of those intangible factors that go very far toward determining the success or failure of such a plant. It is like that advantage of shop clearness cited by Mr. Richmond, and clearness has no coefficient of value. There is one point, however, where I must differ from the author. As I understood him, he said that in an ordinary machine shop the tools are used most of the time; but as far as my experience goes, and I am willing to make the statement applicable beyond the range of my own experience, there are very few shops where all the tools are used any considerable fraction of the time—in fact, I do not believe that the average load of work is more than 30 per cent. of the total capacity. Figures have been given by Mr. Lufkin, which show from 25 to 27 per cent. These may possibly be low, but I should think that 35 per cent. would be high. I mean by this an average taken year in and year out for the general run of shops. Now, when the shop is running light and only a few tools are operated, the electric system can be run at perfect efficiency nearly as well as if the whole shop were running; whereas any other system would be very uneconomical. It is thus especially adaptable to overtime work, which may be done with a small connected engine and dynamo of 5 H.P. or 10 H.P., while the same work done with the ordinary system would require the main engine to be operated. It may, therefore, be asserted that, where the work is variable, the electric system becomes especially advantageous—in fact, would seem to be almost essential to the best economy.

Mr. Oberlin Smith: It is probable that, in the matter of power, we can call it even between electricity and steam, with a balance in favor of the former on account of the intermittent running of the machines. At present the state of the art is crude, and better and more mechanical methods of transmitting power from the motor to the machine must be used, so that there is not so much waste in gearing, pulleys, shafting and belting as we now find in most designs. It, therefore, seems to me that the introduction of motors on individual machines depends on three things: one, the speed with which designers of motors and machine tools adapt them to each other; second, the first cost of the motors; and third, the expense of maintenance. At present it would seem that it is the first cost of the motor that is holding the work back, as expense of maintenance is comparatively little.

Mr. Fay: The question of first cost for an electric installation, which Mr. Smith has raised, depends on whether you direct connect a motor for the machine or whether you group—that is, the first cost is influenced by the question of direct connection or otherwise. We have for the installation where there is a motor for each machine a high first cost, where the motors are grouped at comparatively low first cost. The question of bringing the first cost down by manufacturing cheaper motors is, in my opinion, a matter not worthy of very serious consideration at this date. Electric companies would probably find it very difficult to pay dividends if they manufactured motors on the basis of copper at 12 cents a pound and iron at 3 cents a pound. There are other considerations. When the purchasers learn to select the motors promptly, buy them quickly, put the seller to as little trouble as possible, that will take off 40 or 50 per cent. of the cost, and that is one of the considerations. (*Laughter and applause.*) We come down to this question of a motor for a machine. We have given the matter serious consideration, and we have come to the conclusion, subject to change without notice, that it is not always proper or profitable to put a motor on every machine. We cannot imagine for a moment that the gear takes the place of the belt and does the work any better than a belt. It may be English, but it takes just as much power. Recognizing this fact, that a gear is a substitute for a belt—that is, oftentimes worse and not very often better—we have decided to build motors that would run at the speed you require without gear or belt, and we are building them to-day. But we do not believe the efficiency of a very small motor is high enough to pay for using it at all if we can possibly help it. To get down to figures, we have some 3-H.P. motors that will give us a commercial efficiency of 88 per cent., sometimes a little higher. A $\frac{1}{2}$-H.P. motor is a pretty good one at 60 per cent. Taking 15 or 20 per cent. loss out of the belt transmission and putting it into a motor will not increase the dividends at all; and it very frequently happens that the increased first cost of a very small motor, and the decreased efficiency which is the result of using it, will be a barrier which makes it more profitable to put several small machines of a kindred nature on one motor that has an appreciable efficiency. With that end in view we propose to have a motor, say 3 H.P., that runs at, say, 300 revolutions or 250 revolutions per minute, and extend the motor shaft out, connecting up to it one, two, three, four or five small drills or lathes or other things taking a fraction of a H.P. I have taken some measurements of that extension, and I find that 20 ft. of armature shaft extension might add a loss of $\frac{1}{10}$ H.P. We start out with an efficiency for this 3-H.P. motor, we will say, of 85 per cent.; if you want to feel very safe, decreasing that, with a loss of $\frac{1}{10}$ H. P., and then you have your total losses, when you have five or six or three or four kindred machines running from one motor. Now, comparing that with six $\frac{1}{2}$-H.P. motors at an efficiency of 50 or 60 per cent., we do not even need to guess at what the result will be. We therefore have concluded in a general way that direct connection is the proper thing if you can get a motor that will run so slow as to do away with the gear; or, if you cannot do this, the question of whether you use a single length of belt or gear will not effect the efficiency at all, and that is a mere matter of convenience. If a machine takes a small amount of power, as I say, we figure on putting three or four or five of them together—enough to make a load for a motor that has an appreciable efficiency. The question of speed is another matter. The use of rheostats for varying the speed is a piece of antiquity for which we have very little respect. We are aware of the fact that rheostats have been used for this purpose—would not swear to it but what they are used now. (*Laughter.*) I think I saw one to-day. But there is no need for them. In the past motors were designed so that if we undertook to weaken the field with a view to increase the speed, which would be the result of reactive effects of the armature, it brought us down to the sparking effect of the commutator, of which most of us know the result. We very soon have to send over to the manufacturers for a new commutator, and they say repairs are legitimate prey. In order that we would not have to use a rheostat because our commutator would wear out if we undertook to weaken the field in order to vary the speed, we built a new motor. That is the only remedy that we could find for it; and at the present time we have such a motor as will give us a difference in speed of 100 per cent. without any sparking whatever, and it is done by field commutation. That is the simplest way out of it. All that is necessary in order that speeds may be changed is to get a motor that will not spark when the field is weak. That involves the necessity of studying the design carefully, and that is what you pay the manufacturer for. We therefore are able to say to the gentlemen that the speed can be changed without this loss referred to. The cumbersome train of gears is unnecessary because we bring the motor speed down to meet the conditions direct. The first cost is a hopeless case. Motors do cost money. There is probably only one place that will permit of any reduction in the cost, and that is the question of general expense. General expense covers a multitude of sins of course; but one of the greatest sins against general expense is the terrific cost of getting people to buy motors.

Mr. Platt: It was very interesting to me to hear this evening of the developments in electric motors and motor driving, for I probably witnessed what was the first motor plant for transmission in existence. At least it is claimed in England to be the first. When I was at school I used to go down to South Wales, and in a colliery there they were driving electric pumps with a 3-H.P. Schuckert motor brought over from Germany especially for that purpose, as I believe there was no motor made in England at that time at all. That worked until 1883, and then they put in a Siemens motor and drove the same kind of a plant, and I saw that working three years ago, and it was in perfect condition. They had, of course, to renew the armature once or twice in about 12 years, and that was all. The old Schuckert worked for five or six years, and worked perfectly. So that one can go back even more than 15 years and find quite successful driving under ground in conditions not at all favorable for electric work, so much so that people five or six years ago would hardly have thought it possible. Four years ago I took up electrical transmission in England, and one of the first things I paid attention to was the driving of capstans for hauling trucks. We took motors and put them in a box with gearing and drove a capstan head. It was a compound wound motor, and the capstan head would run from 60 or 80 revolutions down to 40, and we had no trouble from sparking, and

the thing worked perfectly satisfactorily, and is working to-day just the same. The great trouble with it of course was that the only motors they were giving us were running at not less than 1,150 to 1,500 revolutions, and we had to gear them down, and that has been until the last 12 months I suppose, the most serious difficulty in electric transmission. Now that we are getting motors to run at 250 to 300 revolutions, we shall get a condition of things where mechanical engineers can probably take hold. From my experience in England, and from some I have had here, it seems to me that the points put forward by Mr. Fay are worthy of a good deal of consideration. One-H P. motors and ½-H.P. motors have been spoken of for driving lathes. I do not think it is possible, when you come to consider the throwing off and on of the belt and the number of times you have to stop and start in running the lathe, that a motor can be stopped and started economically in that time, and I should think for some time to come we shall have to be content with the grouping of lathes and machines on a certain length of shafting. I question whether we shall find much saving from trying to drive on the machine. Take any large machine shop, extending over any area, and you will find that the great loss is always in transmission to long distances. It is the driving of the big lengths of shafts. I have a shop in view in which I did a good deal of work. It was a car works. We transmitted, I suppose, through 500 or 600 ft. of shafting. We had a rope-driven crane right at the end of that shaft ; and they often have to drive the whole of the shafting of about 100 H.P. to drive this one crane. Right after that a case came up of driving a large band saw—an 8-ft. wheel for sawing large oak logs, that had to be put out in the middle of a yard. If I had had to carry shafting to it it would have cost in the neighborhood of a couple of thousand dollars. It was a long way from any steam. We would have had to take steam 400 or 500 ft. I put in a 60-H.P. motor for driving this band saw, and it has given perfect success. It is particularly adapted for that work, because you start in with a log 5 ft. at the base and going down to 2 ft. at the point, and the power was practically proportional to the work being done. It does seem to me now that in the condition that we are in, with slow-running motors we shall be able to do a great deal more in running our machine shops and getting a very successful working plant. The question of economy has been brought up. Within the last few weeks two authorities have spoken on the subject, one an electrical authority and the other a mechanical authority, both electrical men now—Mr. Crompton, who is the President of the Electrical Engineers in England, and Professor Kennedy, the late President, and who was a mechanical engineer. Kennedy says he does not think that there is any economy in electrical transmission for shop practice. Crompton says he thinks there is a great deal. Crompton is speaking as an electrical and Kennedy as a mechanical engineer. Mr. Richmond spoke of the cost of working being so much in proportion to the cost of driving the machine. I think that is a point that will decide a good many of the cases that will come up in electrical transmission. You will find that it is a question of how much you are going to save in economy of running and not in just the economy of power used.

Mr. Davis: There is a case in point that I am rather surprised Mr. Richmond has not mentioned. The Southwark Foundry & Machine Company, of Philadelphia, were obliged a few years ago to go into the electric driving of certain machines. They were building Porter-Allen engines. They had not any tools suitable to handle the bed plates. They had quite a number of portable tools, such as the slotters, and they were led to take these tools to the work because the work was too large to take to their machine, and they developed a very beautiful system of electric transmission. It was a portable system of electric transmission by which they took their machine to the work instead of taking the work to the machine. I think that is one of the branches of electric transmission that we have not heard mentioned to-night and which they have put to a very good practical use. I think their work has developed by means of those electric motors to an extent that would have been utterly impossible without them.

Mr. Henderson: There is another advantage that has not been mentioned this evening, and that is in arranging the roof trusses of a building ; if we are designing a building and intend to put in shafting, it is customary to increase the trusses in the neighborhood of 10 per cent., and also arrange the trusses in even bays, so that they will support the shafting properly, and also to arrange the windows. If we do not have to pay any regard to this extra weight of the trusses, we can arrange the windows and trusses in a more satisfactory manner.

Professor Crocker: In reply to a question as to the best voltage to be used for shop practice, I should say that there is no particular point that would be best, but would recommend a medium voltage of from 250 to 300. This is neither very nigh nor very low. It is high enough so that the cost of the wires is small and low enough to be entirely safe, while the motors work well at this point, since the current on the commutator is not large enough to cause sparking. In the case of long distances, however, it might be necessary to raise the voltage, while for a very short distance 110 volts might be used. Another advantage would be that two incandescent lamps in series could be used on the same system, or a three-wire electric lighting system might be employed

Mr. Ayer: I want to qualify Professor Crocker's statement about the voltage. I think that should receive a little further explanation. Two hundred and fifty volts, extending over a large area, of course would effect quite a saving, but for general practice in distributing through shops I should say that a 110 volt current was far preferable. The lower potential is quite a considerable factor in maintaining insulation. While it is true that a voltage of 250 is not dangerous to life under ordinary conditions, still with the dirt that is incidental to the transmission, and the maintenance of the line through the shops, which is liable to occur around your machinery, you get more or less difficulty in maintaining your machinery in good condition with a higher voltage than with a lower, and as a rule the extra cost of transmission would not amount to much when considering the advantage gained by the lower voltage—that is, the freedom from accidents. It is certainly a case where local conditions would have to govern.

Professor Crocker: That point, I think, is of considerable importance, and it might be well to consider it a moment. I admit that 110 volts in ordinary cases might be fully as good ; but there is another point, and that is, the carbon brushes have hardly sufficient conductivity to operate for 110 volts. In other words, 110 volts necessitate twice the number of amperes that 220 volts require. Therefore the current capacity needed sometimes runs up to a point where carbon brushes are hardly sufficient, and the use of copper brushes in place of carbon would more than offset any other consideration. That is not an absolutely essential point. You could still use carbon brushes of considerable size ; but it does enter as a question. We use 500 volts very extensively in railway practice and in power distribution, particularly in the West. In fact, power circuits in the West are universally 500 and even 600 volts, and they manage to maintain their insulation, and 220 volts is a mere bagatelle, as regards electrical pressure, compared with 500. So I think there would not be much difference with regard to the insulation. But for short distances the 110 volts would probably be the best ; but as soon as the distances become at all great the amount of copper required would be quite serious.

The Chairman: I think it might be well to call attention to the fact that the discussion this evening has centred chiefly around the practice in machine shops, which was the limitation defined in the address of the evening ; but at various times the debate has branched a little from that, and it would have been, perhaps, still more interesting if it might have included the practice in industrial establishments of other kinds. For example, it has been stated and accepted apparently that the percentage of time during which the machinery in the average machine shop is in use is very small ; it was put as low as 30 per cent. of its total time. Now, in a vastly larger number of industries—industries employing a far larger number of hands than the typical machine shop which is in question—that percentage is very much larger, and approximates more nearly to 100. It certainly ranges as high as 60 and 70, and in some cases 80 and over 80 per cent. of the possible time, and there you will reach conditions so different as to make the treatment of this question of electrical distribution of power substantially different from what it may be under the conditions supposed in the case of machine shops. I think it is a fair conclusion for a listener to adopt this evening that the point which has been reached thus far in the development of electric motors, especially of the small sizes, both as to the first cost of the machines and as to the percentage of their efficiency in use, is such as to make it probably the best practice in the majority of cases to group machines together to an extent sufficient to utilize electric motors of reasonable size giving reasonable efficiency, and not to attempt wholly to eliminate shafting and belting. After all, the objective point of the manufacturer in all of these discussions is to obtain the highest efficiency of men and of machines, and all of these topics bear upon that question.

Professor Hutton: The committee have made arrangements that on the evening of March 13, which is the second Wednesday of March, the subject of the evening shall be the discussion of the rapid-transit problem in this and other large cities. Mr. W. B. Parsons, who is the Chief Engineer of the Rapid Transit Commission, will open the discussion, which will be illustrated by lantern slides.

Adjournment.

PRESSURE AND IMPULSE IN MOTIVE ENGINES.*

A LOOK INTO THE FUTURE.

WHEN a man has spent 30 to 40 years engaged in what is called constructive engineering work, in an advanced environment, with personal powers of discerning tendencies, and understands contemporary practice, he is then in position to render the highest possible service to the world by forecasting the future.

To do this to the best advantage he must withdraw from the activities of practice and personal interest in a particular thing or branch, and must impartially survey the whole field, weighing, measuring, and comparing and considering what the trend is, and what the future will probably bring forth.

Such prognostication is of the very highest value. No other contribution to the world's industry can have more value, even in the intensely practical part. In fact, a great share of the highest human effort is devoted to prying into and endeavoring to find out what future wants will be, and what is likely to best supply these wants. It is the essence, so to speak, of both commerce and manufactures.

The most interesting and important part of such forecast relates to physical discovery in the technical arts, especially in implements, processes, and the control of natural elements, including motive power.

These remarks are suggested by a late letter received from Mr. Charles Brown, C.E., of Basel, Switzerland, containing some forecasts in respect to engineering matters.

Mr. Brown is one of the most eminent constructing engineers now living. This claim has authority far beyond the writer's opinions, but he can add the fact of for twenty years past watching with interest and profit every work and opinion emanating from this distinguished engineer. After a successful career of an average lifetime, in constructing work as diversified perhaps as has ever fallen to the lot of one engineer, bringing to bear thereon a remarkable natural ability coupled with education and training of the highest order, he has now turned back to look over the field passed through, and to draw from it conclusions that deal with the future.

I have no authority to introduce Mr. Brown's name here, and none to quote from his letters before referred to, but it seemed necessary in the present paper to shield myself behind the opinions of one whose views are entitled to much more weight than my own.

Some of Mr. Brown's views, as I gather them from one or two paragraphs in his last letter, and hinted at in previous communications of his, may be stated in the following propositions:

(1) The utilization of the force of fluids, elastic and non-elastic, will in the near future be mainly by impulse instead of pressure.

(2) The impulsion of fluids, elastic and inelastic, will be performed in future by the impulse of the same fluids, set in motion by rotation.

To render these propositions more plain, and connect them with familiar practice, they mean that steam engines, like water wheels and water engines, must abandon direct pressure and pistons for impulse wheels, and that piston pumps and blowing engines must give way to impulse apparatus.

This does not mean that a dynamic and constructive revolution is to take place, and that pumps and steam engines are to be at once changed from present methods of operation. No such proposition is intended, but that the future tendency is to be in that direction, or, as we may say, is in that direction now, to a greater degree than is commonly known or supposed. The proposition must also exclude special appliances, both for elastic and non-elastic fluids, and be confined to what may be called common pumps and motors.

I am not quoting Mr. Brown's words, or paraphrasing them, but am to some extent guessing at his opinions by inference.

Before speaking of the subject in its practical aspect, and as connected with modern engineering practice, some generalization may render it more clear.

Machinery to utilize the gravity of water in descending from a higher to a lower level; machinery to overcome the gravity of water and raise it from a lower to a higher level; and machinery to utilize the expansive force of water converted to steam, or, in other words, water-wheels, steam engines, and pumping machinery, with their attendant elements, constitute a large share of what a mechanical engineer is called upon to study and deal with at this day, and it is to these the propositions before named relate. I will not detain you by statistics of the amount of steam and water power in the world, or its relation to transportation, travel, commerce, manufactures, and even the social conditions of our times. This is too well understood to call for remark.

In the descent of water we have the choice of two methods for utilizing its gravity—pressure or impulse. The first represented by water-pressure engines, gravity or overshot wheels and pressure turbine wheels, such as those of Fourneyron, Jonval and the American types of inward discharge wheels, all operating by pressure caused by obstruction to flow, or, as we may say, receiving pressure directly. The second or impulse method, represented by the Atkins, Girard and Pelton wheels, operating from the impingement of jets set in motion by pressure, or, as we may say, by pressure in its second phase of spouting velocity.

The action of water in the case of enclosed or pressure turbines is not, I am aware, resolved mathematically, as stated above, but this rendering is near enough for the present purpose, which is to show how the two methods of pressure and impulse have in water-wheel practice been contending for 35 years past, dating from the first impulse wheels made by Messrs. Escher, Wyss & Co., of Zurich, Switzerland, about the year 1860. The principal facts of this rivalry will be again referred to.

In steam engines a similar struggle has begun between impulse and pressure. It is young yet, and lacks the history of water-wheel practice, but the future problem is now well before us in both its theoretical and practical aspects, but has not advanced to a place in popular knowledge that permits general discussion.

At this time all popular ideas, as well as nearly all practice, is confined to pressure steam engines of both the piston, or reciprocating, and the rotary kind, mainly the former, but all operating by direct pressure, and maintaining steam-close running joints, as around pistons. The construction and mode of operation is too familiar to require explanation.

In the other class of steam engines—the impulse kind—there is employed the efflux of steam impinging against vanes that move at about .055 of the velocity of the steam, or thereabout; for an average 500 ft. per second, or 30,000 ft. per minute, according to the steam pressure employed. In some cases discharged on the vanes at the initial or boiler pressure, in other cases expanded before impingement, down to atmospheric pressure, the effect being nearly the same, and as the mass, or ponderable weight of the fluid. The velocity is not diminished, and is even increased, at this lower pressure by means we need not inquire into here.

Here we have a strange analogy between the application of elastic and inelastic fluids, between water and steam, and in a change from pressure to impulse action. The same laws apply in respect to the relative velocity of motors, the method of application is nearly the same; in fact, impulse water-wheels have in some cases been driven by steam.

The main distinction is in the respective velocities of efflux and consequent speed of the motors. For water we have $V = \sqrt{2gH}$, and for steam $V = 60\sqrt{T + 460}$, both in feet per second, or comparing for a pressure of 100 lbs. to an inch as eight to one. At this pressure a steam-driven wheel to operate economically would have to attain, as before remarked, a speed of about 500 ft. per second, 30,000 ft., or more than 5.5 miles a minute.

Before referring to the tendencies in present practice, and considering what the future may bring forth, I will point out that a first conclusion will be that all these things are amenable to computation, and can be solved mathematically. This is unfortunately not the case. Some of the conditions, and even the dynamic results, may be thus arrived at, and have been in the case of Parsons' impulse steam engines, also Dr. De Laval's, but the main problems are of a constructive nature, pertaining to the maintenance of high velocities, balancing, lubrication and the elements of transmission.

Still it must be admitted that but little progress can be made without the aid of computation in verifying and explaining results in so far as forces and resistances, but, as remarked, the chief problem lies in that branch of engineering we call constructive. For example, a theoretical steam engine would be one of the rotary type, sustaining direct pressure, and moving at velocities not at all attainable in such engines, even if they were a possible machine on other grounds, which they are not.

The strange proportions of parts would never have been resolved as they are found in practice either by inference or computation, but being found, then new light is added by theory; definite rules are arrived at, the direction and measure of inherent forces are made plain, the thermal conditions

* A paper read before the Technical Society of the Pacific Coast, by John Richards, January 4, 1895. Reprinted by permission of the Society.

are explained; but first and mainly must come the constructive idea or design qualified by working conditions so obscure as to defy human wisdom until tentatively developed by long and tedious experiments dealt with empirically, often blindly, and no small share arrived at by accident. This has been the common course in the past, and is now to a great extent the course followed, but in some instances progress has been the other way, not from construction, use and experiment, but in attempting to supply mechanism to accomplish certain computed results.

Pressure and impulse steam engines furnish two notable examples of these two methods of development. The first were a constructive and experimental problem throughout three-fourths of their history, before the study of thermal laws became a part of steam engineering. Then by both computation and a higher constructive skill the advance during 20 years past has produced our modern types, approaching nearly to ultimate efficiency for the pressure system as it now exists. The course of impulse-engine development is different. It starts with all the aids that have attended the final work on pressure engines, but on the whole the system or method has in 10 years made nearly as much progress as the pressure or piston type did in a century; that is, from a steam consumption of 48 lbs. per H.P. down to 14.5 lbs., or high efficiency for a modern expanding engine of the piston type. This matter is mentioned as one factor to be taken into account in forecasting the future and interpreting signs that increase from month to month.

Reverting now to the practical part, and first to water wheels, we can easily follow the advance made in the impulse type. The first discovery and proposition of this method, so far as I can trace it, originated with Mr. Jearum Atkins, an American, now in his old age an inmate of the Mechanics' Home, in Philadelphia. He presented his invention of open or impulse turbine wheels in the American Patent Office in 1853, where it could not be understood, and a patent was refused. He at that time filed in the office a complete analysis of the theory upon which these wheels operate, clear, concise, and to-day one of the most lucid descriptions that can be referred to.

In 1875, 22 years later, a patent was granted to him for the same invention; but before this time—about 1860 - impulse turbine wheels had been taken up by some of the foremost engineers in Europe, and had become a standard type in France and Switzerland. At the present time, and for 15 years past, no other form of water-wheels have been thought of there, or in other European countries, for heads exceeding 50 ft.

The practice is very uniform all over Europe, and the number of impulse wheels made must exceed pressure turbines three to one. The great wheels at Niagara are a modification of the Girard or impulse system, more nearly impulse than pressure wheels, the plans being supplied by Messrs. Faesch & Picard, of Geneva, Switzerland, who were among the early makers of Girard wheels.

On this coast I need hardly say that tangential wheels, a purely impulse type, have displaced pressure turbines for all except low heads, with gain in efficiency, a saving in first cost and in maintenance. The impulse method has in fact been successful in all cases of competition up to a limitation by the volume of water that for constructive reasons renders the system inapplicable for low heads, and when wheels require to be submerged.

The change from pressure to impulse in water-wheels is, however, by no means so great a change as that between pressure and impulse steam engines. The initial velocity of water, or of wheels driven by this element, is the same in both cases, but with steam the initial velocity is changed, as we have seen, as fifty or sixty to one, giving rise to new and extraordinary differences. To make these more plain, I will again enumerate with more detail the conditions of operating with pressure or piston engines.

The weight and space occupied by motive engines of all kinds are, as a rule, inversely as the velocity of the "actuating parts," and by such a rule pressure engines should be fifty times the weight of impulse engines. The running joints or bearings for pistons, valve-rods, valves, guides, connections, and so on, consuming from 6 to 10 per cent. of the developed power in piston engines, are nearly avoided in the impulse type, but are to some extent, not known, balanced with losses by air friction on the impulse wheels. The elements of transmission between the piston and crank shaft have at all points throughout to withstand the full measure of strain imparted to the crank-pin, not uniformly, but in a series of waves, to so call it, consequently these elements are about five times as heavy and expensive as when the initial movement corresponds to .055 that of the flow of steam, or is eight times greater. The change also simplifies such gearing.

Vibration, due to intermittent stress and reciprocating parts, is a serious objection and impediment in the pressure system. It calls for ponderous fastenings and foundations that, with lavish plans and material, especially in vessels, is only partially successful.

Fly-wheels have to be provided to equalize the variable turning moments in all land engines. This function is supplied in vessels by paddle-wheels, screws and multiple engines, but a fly-wheel of some kind is an essential part of an ordinary piston engine.

We have then in this case a motor moving at 8 to 10 ft. a second, impelled by a fluid whose normal flow is 800 to 900 ft. a second, fifty times the weight and ten times the space occupied that would be required if the steam could be directly applied. There is, however, one difference that must be kept in mind: that in engines driven by the impulse of steam a certain speed must be maintained, while in piston engines this is variable in any degree.

For most purposes this latter feature is not important, but is indispensable for traction, and we need not look for change in that branch of steam machinery. The same fault would in some degree apply in navigation where variable speed is necessary, as in the case of boats making frequent landings, but not for ocean service.

This difficulty in impulse engines arises from the fact that the flow of steam follows a different law from that of liquids, and is computed as a function of temperature, instead of pressure or head, varying only 35 ft. a second between 25 and 100 lbs. pressure, and only 10 ft. a second between 100 and 150 lbs. per in.; consequently speed cannot be controlled by volume.

But outside of all uses requiring variable speed there is left a much wider field for impulse engines, and considering the objections to the pressure or piston system before pointed out, we cannot wonder that men learned in these matters should set about finding out some escape from such sacrifices made to mechanical expediency. I am not able to name but a few of the eminent engineers who have considered and are engaged in developing the impulse system for steam engines.

First may be named Dr. De Laval, of Stockholm, Sweden, inventor of the centrifugal cream separators, who to impel these high-speed machines conceived the idea of a steam-driven impulse wheel, operating by the direct efflux of a jet applied on vanes. This, as we believe, was about 10 years ago. The object was not efficiency or novelty, but a high initial rate of rotation to avoid transmission gearing. The result was so remarkable as to lead on to further experiments and results until a steam consumption as low as 40 lbs. per H.P. per hour was attained.

Then the matter began to attract attention, and the Hon. C. A. Parsons began, in England, a series of exhaustive experiments, connected with careful computations of the thermal and dynamic conditions attending on the impulse method, and now at the end of less than ten years he has removed modern compound piston steam engines in the city of London, and replaced them with steam turbines or impulse engines. This was done in one of the stations erected only a short time ago, and, as Mr. Brown remarks in his letter before referred to, "is a most significant fact." It is more than a year since the editior of *Engineering*—a high authority—conceded that the impulse steam engine had attained the same efficiency as a two-cylinder compound piston engine.

Able engineers all over Europe have this problem in hand now, and if, as Mr. Brown writes, steam consumption has been reduced to 6.5 kilograms, or 14.5 lbs. per H.P. per hour, the thermal problem is done—that is, the efficiency has overtaken the pressure engine; and now remains a development of various constructive problems that are almost sure to be rapidly worked out.

The speed of impulse engines follows the same law that applies to all motors driven by the efflux of fluids, the residual velocity, or, as we may say, the residual "rest," because there should be no velocity in the spent steam, is a resultant of two components, the movement of the fluid and that of the motor, the former being reversed in its course, and the relative speeds of the steam and the vanes or buckets being as 100 to 55. This rule produced in the first engines of De Laval and Parsons from 20,000 to 30,000 revolutions per minute. Five years of constructive effort has reduced these enormous velocities of rotation to one-third as much, and to a point where direct connection to the armatures of electrical dynamos is possible, and the required gearing of transmission is brought well within the resources of modern practice.

The conditions of operation in pressure or piston engines have been in part pointed out, and, as said, disclose the incentives that have led to the impulse method. Ultimate efficiency is not the object. This cannot in the nature of things vary

much between pressure and impulse. The force of efflux in fluids is equal to their gravity multiplied into their velocity, less the friction of orifices, and apparatus that will utilize the impinging force in the same degree that pressure is utilized by pistons will be equally efficient, other things being equal; so the objects to be attained by the impulse method for steam engines lies in another direction.

It will be revolutionary to institute complete comparison, and unfair in the present state of the impulse method, only ten years old, dating from the De Laval experiments. Steam consumption has fallen from 48 lbs. to 14.5 lbs. in that time, and from being a curious experiment the impulse engine has thrust itself in among its venerable competitors, not in obscure corners, but in high places. The electrical generators on the two greatest transatlantic steamers are driven by impulse engines, supplied by Mr. Parsons about four years ago. There are many other cases that cannot be called to mind at this time.

Other inventions of equal extent rise in these times, pass into the industrial field and soon disappear in the whirl of progress and change that characterizes our age and time, but here is one of different nature and portent.

The application of motive fluids by impulse instead of direct pressure, that came about almost insensibly in water, means a wide revolution in steam, one that will not only modify constructively and economically nearly all that pertains to steam power, but will widen the field of application to hundreds of purposes not now thought of.

Mr. Brown informs me that he is considering the application of impulse engines to traction purposes, but has naturally met with the impediment of variable speed, almost the only fundamental virtue inherent in the piston engine, and, as before said, confined mainly to this very case, so that he has attacked the exaggerated end of the problem, and will most likely abandon the scheme.

One other feature of impulse engines remains to be noticed. Expansion to the fullest degree must be a characteristic of any economical steam engine. This Mr. Parsons provided for at first in nine stages, and to transfer from one stage to the next involved a principal feature of objection to pressure engines, that of maintaining steam-tight running joints, not actual contact between surfaces in this case, but joints of such precision that, while not in contact, no considerable leak could pass through them.

This calls for an accuracy of work that cannot be attained with ordinary implements and by ordinary skill, but the De Laval engine avoids all this by a single application of the steam, first expanding it to the pressure of the atmosphere, and converting the expansive force into velocity.

This is in my opinion the key-note to the whole system, because engines thus made require no close running joints, and are simple in all their elements, down to the reducing gearing, and this, as now constructed, seems to operate without difficulty.

For eight years I have urged on all possible occasions the attention of engineers on this coast to impulse steam engines, and their importance for special if not general purposes. These propositions have been treated, like perhaps the present paper may be, as a visionary matter, but however this may turn out, I am getting into very respectable company, and feel encouraged accordingly, hoping even to see at some future time an engine of 100 H.P. wheeled on a hand-barrow, a quiet, undemonstrative little machine that can be set in some corner out of the way on a common floor; also to see power distributed by impulse air engines over wide districts without much loss in transmission, without heat, danger, or the complication of electrical apparatus even.

This is, perhaps, enough for one occasion, and all that it is safe to say; but having the floor, I may as well go on and shock the engineering proprieties with the second proposition, relating to impulse, laid down at the beginning. It was as follows:

"The impulsion of fluids, elastic and non-elastic, will in future be performed by impulse derived from the momentum of rotation."

This proposition, almost wholly new to me, comes in a rough pen sketch and some explanation by Mr. Brown of what he calls the centrifugal pump of the late Emile Bourdon, an engineer whose name will be familiar to most of those present by reason of his other inventions relating to fluid action.

Fourteen years ago, when I undertook the construction of centrifugal pumps here in San Francisco, I was informed by people whose opinions were certainly to be considered that pumps of that kind would not operate against heads exceeding 40 ft., and they proved it, too, by rules, showing that an increase of resistances with head fixed a commercial, if not practicable limit at that pressure. Combining two pumps, I found their force in series was multiplied accordingly, and a pump to operate against a head of 80 ft. was made and operated successfully.

Single pumps have since then been made to raise water 160 ft. without encountering the theoretical resistances commonly set forth in authorities, and I have the boldness to believe that the theories applied to these pumps are wrong, and that what we call the centrifugal method of pumping has no such limits as have been fixed by computation. I presented in a previous paper before this Society the enormous increase of capacity, and a corresponding decrease in cost, of continuous flow pumps, and came near some predictions that, if the paper were to be written now, would form a portion of it.

Heretofore we have operated in one line of construction, or method, for generating what we call centrifugal force, or a force derived by rotation for impelling fluids; but, if instead of centrifugal force, we consider the momentum of revolution, and deliver this momentum impulsively to the performance of work, we are carried into a new field, and the limitations of the centrifugal pumping will disappear, theoretically at least.

If a body of water is set in revolution by being dragged over large frictional areas by an impeller whose velocity at different radii cannot conform to that of the water, we cannot expect to impart to the water a very large proportion of the original energy, or driving power, employed to set the water in motion; but if the water is gradually set in rotation, almost without friction or retarding influence, except its inertia, that water applied impulsively should give out again in useful effect within a few per cent. of the original energy or power. To do this the water should not be whirled around in a stationary vessel or case, but in one revolving at the rate desired for the water to attain, and the impulsive effect taken off, so to speak, by impingement on the fluid to be raised or impelled.

It is, perhaps, inexpedient and unfair to bring to the Society's notice a matter so little supported by tangible data at this time; but knowing that some of our members are now engaged in hydraulic problems relating to the impulsion of fluids without the losses of intermittent motion, and as the Bourdon pump is an impulse machine, it cannot be passed by. The proposition involves both the generation and application of the pumping or impelling force, and there is, of course, no direct analogy to steam engines and water-wheels that draw from an accumulated store of energy.

The Bourdon scheme involves a translation, it may be called, of the energy as well as its application by impulsive effect.

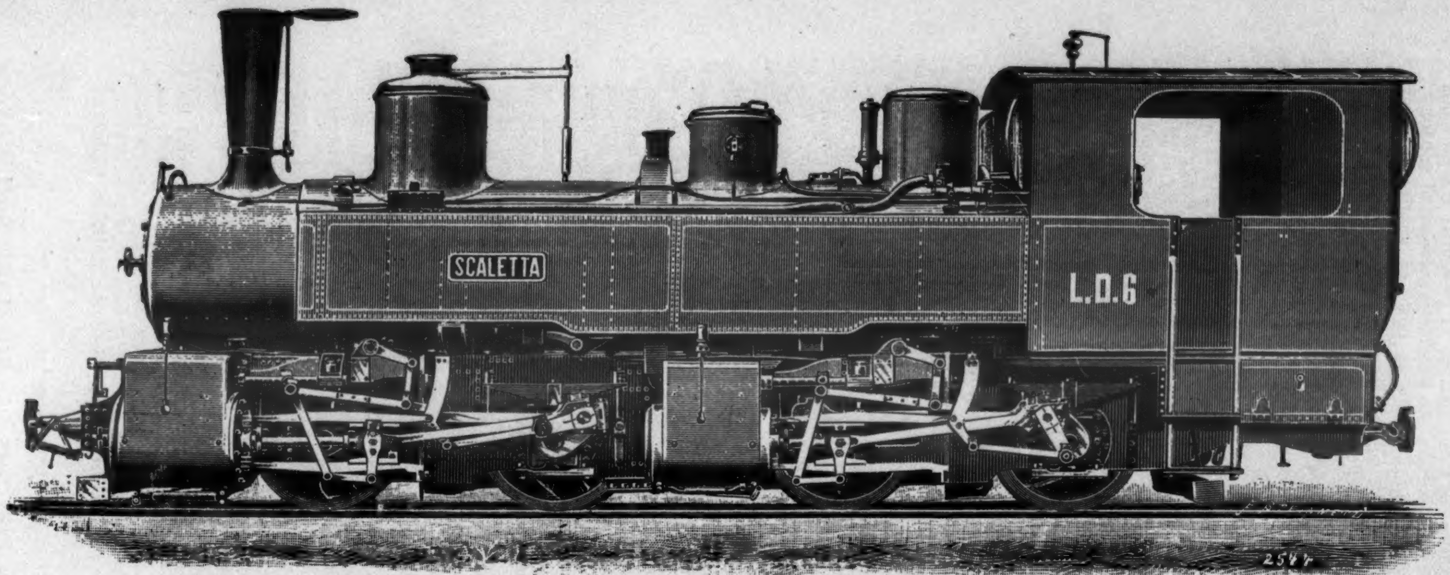
Suppose that a cylindrical vessel like a centrifugal drying machine, having inward projecting vanes around its interior periphery, is filled with water, and set in revolution up to a velocity of 80 ft. per second at the interior tips of the vanes. The water would then be moving at a rate the same as that produced by a head of 100 ft., and if this water could be diverted tangentially, and directly applied to the propulsion of other water to be raised or impelled, the losses would be inconsiderable. To take off this revolving water tangentially a discharge nozzle has to be introduced inside of the revolving chamber. This discharge pipe would, of course, obstruct or prevent rotation of the water in the zone occupied, creating a frictional area equal to the width of the revolving chamber multiplied by a circle touching the end of the discharge pipe. This frictional area is not more than a third what is encountered in a common centrifugal pump, and is that of viscosity principally.

This indicates in words the experiments being tried by Mr. Brown, who, as I understand, proposes velocities far beyond precedent, or possible, with a common centrifugal pump. The same method can be applied to air or any elastic fluid the same as water.

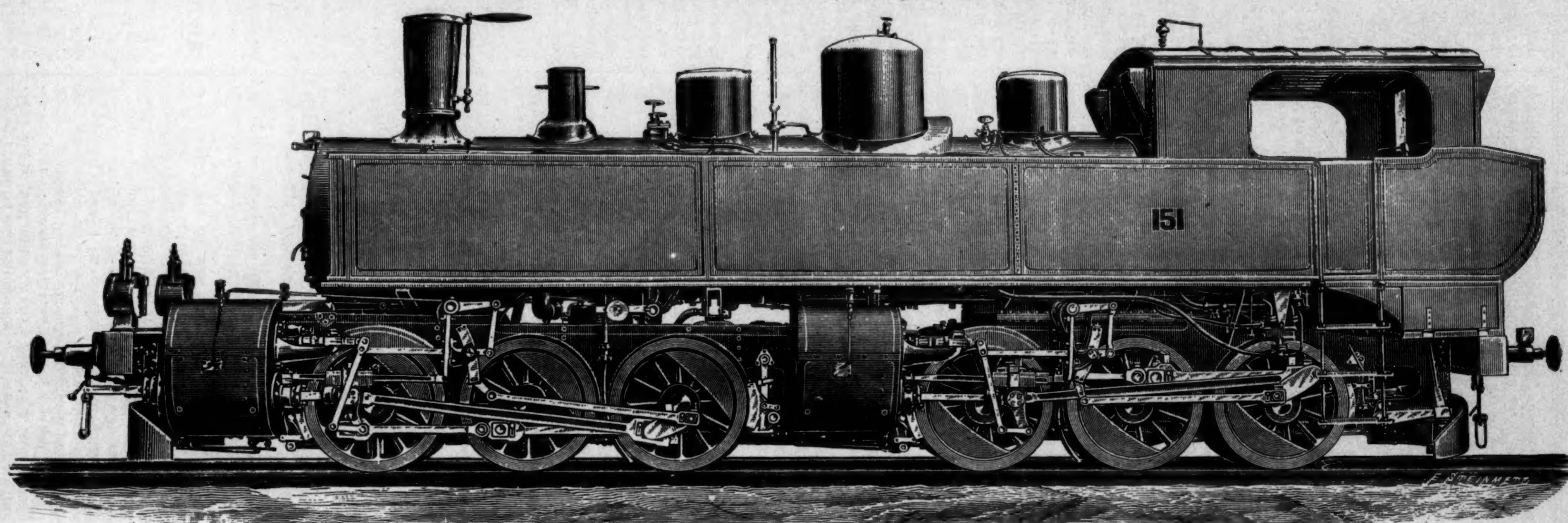
There may be present members who are familiar with the experiments and views of M. Bourdon. I will not pursue the matter further now, but with consent may at some future time lay before the Society some results of experiments now going on that may modify present views of the impulse method of translating energy.

ENGINES FOR THE ST. GOTHARD RAILWAY.

In a recently published table *Engineering* gives the lengths and weights with the fuel consumption of the locomotives that are in use on the St. Gothard Railway, in which it is shown that the weight of the goods engines has gradually increased from 56 to 87 tons, and that of the passenger engines from 56 to 100 tons, the greatest load on one pair of wheels being 16 tons. The heaviest engines of both classes are the two types lately acquired—viz., the 87-ton duplex-compound Mallet engine for heavy goods traffic on the mountain sections,



COMPOUND DUPLEX TANK LOCOMOTIVE; LANDQUART-DAVOS RAILWAY.



ST. GOTHARD 87-TON DUPLEX MALLET COMPOUND FREIGHT LOCOMOTIVE, BUILT AT THE MAFFEI WORKS, MUNICH.

and the 100-ton three and four-compound engines for express passenger service over the whole line. Of these two types, the 87-ton Mallet engine, built in 1891 by the Maffei Works of Munich, has now been running for two years, while the 100-ton compound express engines, built at the Swiss Locomotive Works at Winterthur, have only been recently put on the line.

The following are the leading dimensions of the duplex-compound 87-ton engine which is illustrated on page 120:

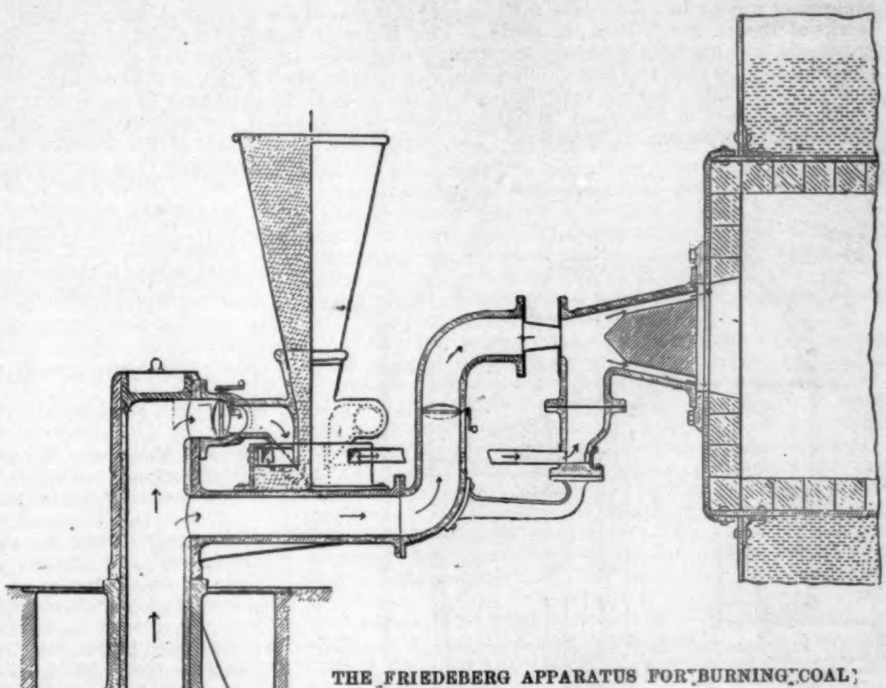
Diameter of high-pressure cylinders	15.7 in.
" " low " "	22.8 in.
Stroke	25.2 in.
Pressure in boiler	177 lbs. per sq. in.
Diameter of wheels	4 ft.
Total heating surface	1,660 sq. ft.
Grate area	23.6 sq. ft.
Weight empty	69.4 tons.
Fuel	4.3 tons.
Water in tank and boiler	13.5 tons.
Total weight in working order	87.2 tons.

At 50 per cent. admission, the tractive power of the engine is 9 tons. The power developed at a speed of 12.5 miles per hour on the maximum (2.7 per cent.) grade with a load of 200 tons, and under favorable conditions of adhesion —viz., with a coefficient of traction of 11 lbs. per ton, works out at 760 H.P. The average consumption of fuel is 67 lbs. per mile, but on the steepest grades it is no less than 1,666 lbs. per hour, or close upon 160 lbs. per mile. This is 2.5 times the average consumption of the engine and 3.5 times that of the average consumption of the other engines. The consumption of grease and oil of this engine is as much as 0 35 lb. per mile run, or nearly twice as much as the average of the other engines, which is 0.18 lb. Again, its tractive power is only about one-tenth of its weight, and altogether the internal resistances of the engine are so enormous that its working results cannot be described as favorable. On the other hand, smaller engines of this type —viz., eight-wheeled, weighing only 41 tons full, and giving a tractive power of 6 tons, or one-seventh, have given very good results on the metre gauge railway from Landquart to Davos. The average gradient of that line is 2, the maximum 4.5 per cent., and the average consumption of fuel of the compound engines, of which an illustration is given with the other engine on page 120, is only 38 lbs. per mile.

THE FRIEDEBERG APPARATUS FOR BURNING COAL DUST.

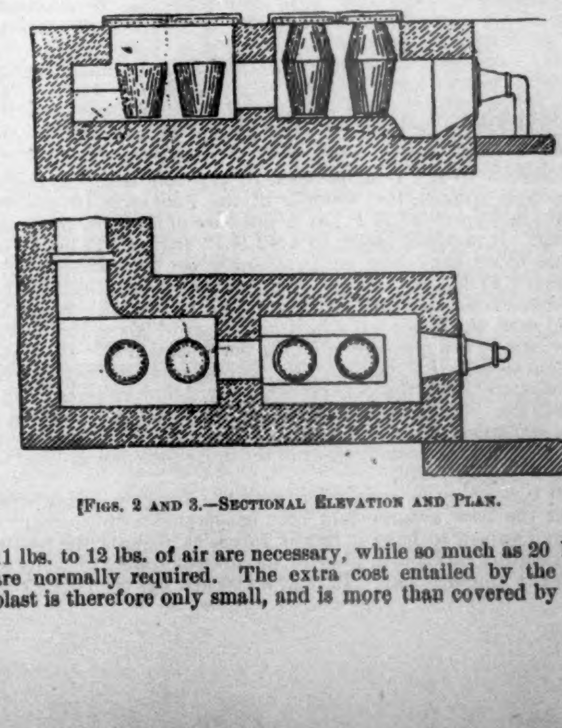
THE apparatus which we are about to describe is the invention of Herr Friedeberg, and has been introduced in Germany by the Allgemeine Kohlenstaubfeuerung Actiengesellschaft, Patente Friedeberg of Berlin. Arrangements of the kind are not exactly new, but the present one is an improvement in that the coal dust is not fed into the furnace by means of revolving or swinging grates, but by means of an air blast. Referring to the illustrations, fig. 1 shows a section through the arrangement. The vertical blast-pipe, seen to the left, is closed at the top and provided on one side with two round openings. Around this is arranged a revolving casing, fitted with two pipes in such a position that when the apparatus is ready to be put in operation, and during operation, the pipes coincide with the openings just referred to. When it is desired to cut off the blast and stop feeding the furnace, the *whole* arrangement is revolved around the vertical blast pipe, so bringing the pipes against the solid wall of this instead of opposite the openings of the same. The hopper terminates in a box, in the upper half of which are worked two pockets open at the bottom. The upper pipes from the vertical blast-pipe are led into the box by nozzles around the bottom of the hopper. These nozzles are so arranged that the blast moves and blows away the coal dust along the square passages shown, to the delivery pipe. Any small pieces of coal, etc., in the coal dust fall to the bottom of this delivery pipe, from which they may be emptied out as occasion arises by means of a movable cover. Underneath the boxes and hopper supporting them, but not in communication with them, runs a larger horizontal blast-pipe, terminating in the central vertical pipe. This, again, bends horizontally and terminates in a nozzle opening into the base of the conical chamber seen on the right of the illustration (fig. 1). Both the upper blast-pipe and the lower or secondary one are provided with throttle-valves, by means of which the pressure of the air-blast is regulated. The mixed coal dust and air now encounters the full blast from the large lower pipe, which drives it into the conical space between the sides of the hollow cone and the solid core seen to the right. Thus an intimate mixture of air and coal dust is continuously and regularly fed into the furnace.

To create the air blast a Root's blower or other arrangement of the kind may be used, the power required being from ¼ to 1¼ H.P., according to the size of the apparatus and to the quantity of coal dust to be fed to the furnace. Herr Friedeberg, the inventor, states that in order to burn 1 lb. of coal dust only 11 lbs. to 12 lbs. of air are necessary, while so much as 20 lbs. are normally required. The extra cost entailed by the air blast is therefore only small, and is more than covered by the



THE FRIEDEBERG APPARATUS FOR BURNING COAL DUST.

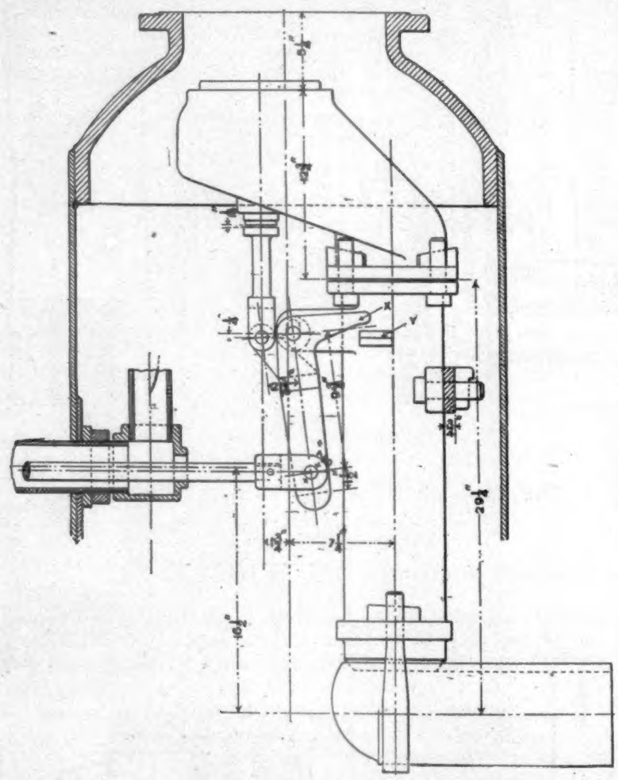
FIG. 1.—SECTIONAL VIEW OF APPARATUS FITTED TO BOILER.



FIGS. 2 AND 3.—SECTIONAL ELEVATION AND PLAN.

more perfect combustion of the fuel obtained by its use. The combustion of the coal dust is so regular and complete that the walls of the fire-box may be quickly brought to a white heat. Up to the present two sizes of this apparatus have been made—one capable of feeding into the furnace from 11 lbs. to 12 lbs., the other from 22 lbs. to 330 lbs. of coal dust per hour. Arrangements are provided for regulating the feeding of the coal dust to the exact quantity required by means of the air-blast. It is claimed that whatever be the pressure of the air-blast, the delivery of the coal dust is perfectly regular, and that no smoke whatever arises from its combustion. The fineness of the coal dust used depends on the kind of coal; the maximum is that passed through a 0.25-mm. mesh screen, the best results being, however, obtained with dust passed through a 0.1 mm. mesh screen. A certain degree of moisture may also be given to the air-blast, according to the kind of fuel used.

One of the first installations of this coal dust burning arrangement was carried out in the early part of this year at the works of Messrs. Arndt Bros., in Berlin. This is a small-size apparatus, and has been working ever since, giving entire satisfaction. Since then two sets of a larger size have been fitted to a Cornish boiler, having two furnaces, at the glass works of Messrs. Ebert & Neumann, at Stralau, near Berlin, and these are still in successful operation. The latter installation



THROTTLE VALVE, PENNSYLVANIA RAILROAD.

is shown in fig. 1 in our issue of the 12th inst. In the first example quoted, the boiler is of the Paucksch tubular type working up to 16 H.P., at a pressure of 105 lbs. per square inch. It supplies steam to a 12-H.P. engine, 715 lbs. of coal dust being consumed on an average per 24 hours, equal to about 4.95 lbs. of fuel per H.P. per hour, including the coal consumed at the start for heating up the boiler. In the second case, the boiler has a heating surface of 90½ square metres, and works at a pressure of 90 lbs. per square inch. It supplies steam to a 50-H.P. engine. In this case ground English steam smalls are used, the consumption per 24 hours amounting to 5,610 lbs. The economy in fuel in the latter case is shown by the statement that the consumption of fuel—of a much better quality than at present—before the arrangement was fitted up, was about 6,930 lbs.

It is not only in connection with the firing of steam boilers that the new arrangement may be adopted with success. It would appear to have a bright future as regards the heating of smelting furnaces in place of the present system of using expensive foundry coke. In fact, a furnace has been constructed for the heating of melting-pots, to the front of which this apparatus has been fitted in place of the so-called French crucible furnace (see figs. 2 and 3). The hearth of the furnace is 9 ft. 10 in. long, the height corresponding to the size of the crucibles or melting-pots. The furnace, as will be seen, is divided into two parts, the front portion serving for the smelting of the metal, while the back part serves to give the crucibles a preliminary heating up. In a furnace of this kind 110 lbs. of copper have been melted down in 45 minutes, including the time occupied in heating up the furnace. The quantity of coal dust consumed per kilogram (2.2 lbs.) of metal was found to be about 13⅛ oz., as against, in the old system, from 2⅛ lbs. to 3⅜ lbs. of foundry coke. Holes are provided in the top of the furnace, fitted, of course, with covers, so that without any interruption in the heating operation, and with only a slight fall in the temperature, one crucible may be taken out and immediately replaced by another one previously slightly heated, smelting operations being thus carried on with more dispatch than formerly. A careful estimate has been made of the cost of the foundry coke previously used and the coal dust now employed, and even allowing for an equal consumption of the two fuels, it is found that there is a saving in cost of over 50 per cent. in favor of coal dust. As a matter of fact, the quantity consumed of the latter is only about one-third that of the foundry coke used, so that the economy is even greater than 50 per cent. It is further claimed that, by the use of Friedeberg's apparatus, the life of the crucibles is lengthened, owing to their not coming into contact with the coke, etc., in the furnace, and that the whole operation is attended with much more cleanliness than has hitherto been the case, while a higher temperature may be attained with the coal dust than with coke.—*Industries and Iron.*

THROTTLE VALVE, PENNSYLVANIA RAILROAD.

Mr. Vogt, the Mechanical Engineer of the Pennsylvania Railroad, has recently designed a new form of throttle valve that is not only exceedingly simple in its construction, but very effective in its operation. There have been innumerable devices to overcome the closing pressure that is exerted on the common form of valve, due to the inequality of the areas of the two seats, but up to the present none of them have been altogether satisfactory on account of the complication that they involve in the attachments or the extra care and expense demanded in the grinding in of extra seats and the making of extra valves. The device that we illustrate is so simple that it seems strange that it has not been brought out earlier. The valve itself is the same as that used on the Pennsylvania and other railroads, and the device consists in giving the engineer a greater opening leverage at the instant of starting the valve than that which he has after it has been opened a little and the steam has entered the dry pipe, and balanced the valve. The valve stem extends down from the valve and takes hold of the bell crank in the usual way. It will be noticed, however, that the arm of the bell crank that is attached to this stem is very short, and that the lower arm to which the rod from the lever is fastened is long. This arrangement gives the engineer a very powerful purchase on the valve, and he is thus enabled to start it with comparative ease. The pin upon which the bell-crank turns passes through a slotted hole in the bracket on the dry-pipe, as shown by the dotted lines on the engraving, and when the valve is closed it is held down to the bottom of this slot by the pressure on the valve. The same thing holds true while the valve is being opened until the back projection *X* of the bell-crank comes down and in contact with the bracket *Y*. Then the leverage instantly changes, and the valve opens more rapidly, while the pin upon which the bell-crank at first turned, rises in the slotted hole already alluded to. It will thus be seen that when considerable power for the starting of the valve is necessary it is available, and that as soon as the valve is opened and thoroughly balanced it opens rapidly and easily.

MEASURES TO PREVENT STRIKES.

The New York State Board of Mediation and Arbitration were ordered by the Legislature to make an investigation of the trolley strike in Brooklyn, and report thereon, with a view to the recommendation of such measures as may prevent such occurrences in future. The report has recently been submitted to the Legislature, and says:

"The additional inquiry failed to throw any new light upon the cause of the strike, which, in a word, was the direct consequence of the inability of the officers of the roads and the executive officers of the employés embraced in District Assembly No. 75, Knights of Labor, to renew for 1895 the contract of 1894 between them, with certain amendments proposed by the latter. This disagreement of the employers and employés, however, was but an apparent or superficial cause—an effect rather than a cause. The primary cause of this Brooklyn strike and of all kindred strikes is to be found in the fact that the Legislature, in creating railroad corporations and vesting in them the public function of transporting persons and property of the people, has neglected to make necessary provisions for a stable and efficient service of operating forces upon the lines to subserve the end for which they were given breath of life and clothed with the State's power of eminent domain.

"Any remedial legislation to be effective should have prevention for its objective point. The interruption of operation of a railroad in its service to the people for which its corporate owner was created, by reason of a controversy or dispute between the company and the operating forces, or strike of the latter, should be made impossible. The measure recommended by this Board is one that would bind alike in mutual obligations both employer and employé, and in outline is as follows:

"1. Declare the service of railroad corporations created by the State a public service.

"2. Entrance into such service to be by agreement for a definite period, upon satisfactory examination as to mental and physical qualifications.

"3. Resignation or dismissal from such service for ordinary cause to be permitted, to be stated in writing and filed with some designated authority, and to take effect after the lapse of a reasonable and fixed period, with proviso for summary resignation or dismissal for extraordinary cause, to be stated and filed in like manner.

"4. Wages to be established at the time of entry, and changed only by mutual agreement or decision by arbitration of a Board chosen by the company and employés, or by a State Board, or through the action of both, the latter serving as an appellate body. Other differences that may arise to be settled in like manner.

"5. Promotions to be made upon a system that may be devised and agreed upon by both parties, with the aid of a State Board, if necessary.

"6. Any combination of two or more persons to embarrass or prevent the operation of a railroad in the service of the people a misdemeanor; and any obstruction of or violence toward a railroad serving the public, endangering the safety of life and property, a felony, with punishment of adequate severity.

"7. Establishment of a beneficiary fund for the relief of employés disabled by sickness or accident and for the relief of their families in case of death, as is done upon the lines of a number of railroad corporations in other States.

"8. Membership in a labor union shall not be used as a bar against the employment of competent workmen by a railroad corporation created by the State.

"All to the end of a discharge of mutual obligation of railroad corporations and employés, the enjoyment of mutual benefits, and the securement of a permanent and satisfactory service to the people, who have a right to it and a right to use every power necessary to obtain it.

"It is confidently believed that a law enacted on the lines of the measures above suggested would insure relief and justice to all.

"A point of very great importance in the operation of railroads, and especially of electric street railways in the congested streets of cities, is that of sight and hearing in motormen and conductors. The trolley roads have been in operation in Brooklyn between two and three years, and during that period more than 600 accidents have been reported, and it would probably be conservative to add 150 to that number. The number of people killed up to the first of the year 1895 is stated at 91; and the State Railroad Commission is reported as stating the number killed during 1894 alone at 45. It is believed that many of these accidents and fatalities are directly traceable to imperfect vision in motormen. That the managers of trolley roads are sensible of this fact is evidenced by the action several months ago of President Beckley, of the Rochester Electric Street Railway, which is conceded to be one of the best managed and most efficient of this class of railroads in the United States, in ordering an examination of its motormen and conductors as to sight and hearing by Dr. Wheelock Rider, an eminent oculist and aurist of Rochester, and making provision for such examination of all applicants for places before employing them in the future. It is suggested that, aside from other legislation touching the operation of railroads, this one point of faculties, of seeing and hearing in the operating forces, as the positions where seeing and hearing are essential, ought to be covered by requirement of statute for examination by a competent oculist and aurist before applicants are taken into the railroad service. Information has been received that men dismissed from service of the Rochester road on account of defective vision and hearing found employment on the Brooklyn roads without question."

LABOR ARBITRATION IN FRANCE.

The following report on legislation on this subject in France was made by Mr. Charles W. Wilcox, Jr., our Consul at St. Etienne, and is dated December 6, 1894. In his report he says:

"Toward the close of the year 1892 the French Chambers enacted a law providing for 'conciliation and arbitration in conflicts between employers and workmen.' The act contemplates the voluntary submission by the parties interested of the questions at issue between them, bearing on the condition of labor, first to a committee of conciliation, consisting of delegates chosen by the respective parties; and, secondly, in case of failure to agree on the part of such committee, to a council of arbitration. The proceedings may be initiated by either party, or, in case of a strike, upon the invitation of the justice of the peace of the district or canton; but in all cases, the agreement of both parties to submit the question is essential. The process is substantially as follows:

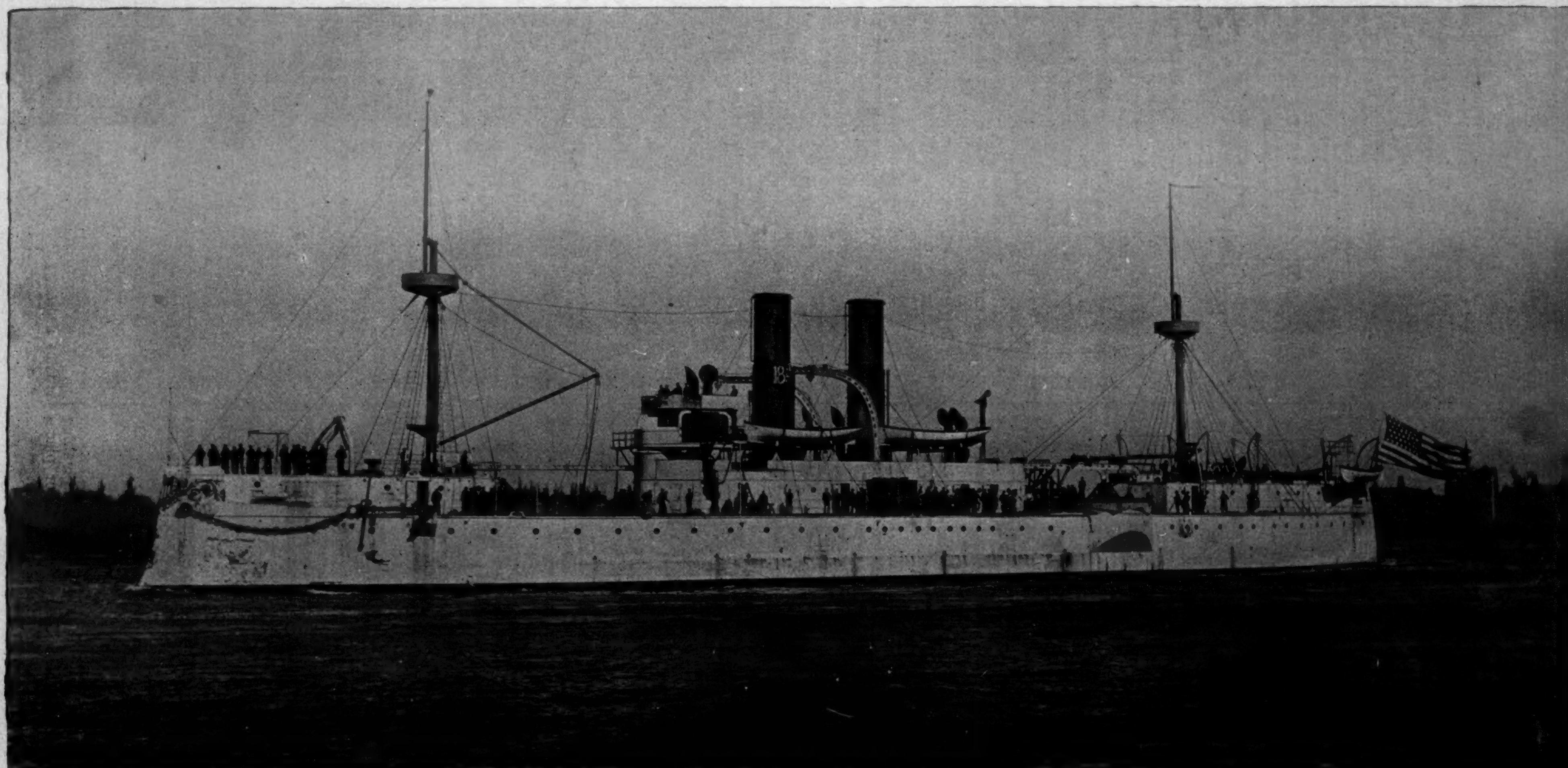
"The parties—employers or workmen—file with the justice of the peace of the canton a written declaration setting forth the names, professions and domicile of the petitioners and of the persons to whom the proposal for conciliation or arbitration is to be addressed; the subject-matter of the conflict, with a detailed statement of the motives or reasons alleged by the respective parties; and the names, professions and domicile of the delegates chosen by the petitioners to assist or represent them. The number of delegates cannot exceed five, and they must be citizens of France. The justice of the peace thereupon delivers a receipt for the declaration, indicating the date and hour of the filing, and causes notice to be served on the adverse parties. An answer to this notification must be filed within three days, a failure so to do being taken as a refusal to submit the matter in controversy. Provision, however, is made for an extension of time upon application made within three days.

"If the proposition is accepted by the adverse parties, they must state in their answer the names, professions, and domicile of the delegates; these delegates being subject, of course, to the same provisions in relation to the number and citizenship as those chosen by the petitioners. After the acceptance is filed, the justice invites the parties or delegates to form at once a 'committee of conciliation.' The meetings of the committee are presided over by the justice. If an agreement is reached by the committee, it is reduced to writing by the justice and signed by the parties or delegates. In the event of a disagreement in committee, arbitrators are chosen on both sides, or, when practicable, a common arbitrator. If the arbitrators fail to agree, they can choose a new arbitrator or referee who will have the casting vote; if they cannot agree upon the selection of such referee, they declare the fact in writing, and, thereupon, such declaration, being transmitted by the justice to the president of the civil court (*president du tribunal civil*), the latter will appoint such referee.

"The decision of the dispute, drawn up and signed by the arbitrators, is remitted to the justice of the peace. The declarations and decisions are preserved in the office of the justice, who delivers a copy to each of the parties, and addresses another, through the prefect of the department, to the Minister of Commerce and Industry.

"In case of a strike, if the initiative has not been taken by any of the parties interested, the justice of the peace, by virtue of his office, calls upon the employers and workmen, or their representatives, to make known to him, within three days, the subject-matter of the controversy, with a detailed statement of the motives or reasons alleged, their acceptance or refusal of conciliation or arbitration, and the names, professions, and domicile of the delegates chosen, if any. If the invitation of the justice is accepted, the proceedings will follow the course heretofore indicated.

"The costs for the furnishing, heating, and lighting of the rooms necessary for the holding of the meetings of the com-



Photographed by Hart, Brooklyn, N. Y.

THE UNITED STATES ARMORED CRUISER "MAINE," BUILT AT THE BROOKLYN NAVY-YARD.

mittee of conciliation and councils of arbitration fall upon the commune, and the expenses of the committees and councils are taxed by decree of the prefect and are charged to the budget of the department.

"It will be noticed that under the law, the recourse to its provisions is purely voluntary, the intention and scope of the act being to furnish a method, not to prescribe a remedy. As to the enforcement of the decision of the council of arbitration the act is silent, and it is to be assumed that in case of a refusal to comply, the injured party would be remitted to his civil suit for damages.

"The recent publication of the report of the director of the Office du Travail, addressed to the Minister of Commerce and Industry, affords an opportunity for judging of the practical operation of the law. The report covers the year 1893. It appears that, during that year, there were 634 strikes, and that proceedings under the provisions of the act were initiated in 109 instances, in all but 7 of these instances a strike having been previously declared. In 56 cases the application came from the workmen; in 5 from the employers; in 2 from employers and workmen together, while the justice of the peace intervened in the remaining 46. The result of these 109 invocations of the law of arbitration is as follows:

"In 13 cases work was resumed before the law could be applied, and in 8 of these the justice had intervened, and in 5 the application had come from the workmen. In 45 other cases the resort to conciliation was frustrated by refusals to submit, 37 of these refusals coming from the employers, 6 from the workmen, and 2 from both sides. In the 37 instances of refusal by employers, the application had been made by the workmen in 28 cases, and the justice had intervened in 9. In the 6 instances of refusal by the workmen, the application had been made by the employers 3 times, the justice intervening in the other 3.

"In the 51 remaining cases, committees of conciliation were constituted, and in 30 instances a satisfactory solution of the differences was obtained, a conclusion being reached by the committee in 25 cases and by a subsequent arbitration in 5. In 9 of these proceedings the demands of the workmen were granted, in 3 refused, and a compromise decision reached in 18.

"The 21 other submissions failed of any practical result, 1 because two successive referees appointed by the President of the civil court declined to serve, 2 because the workmen refused to ratify the decisions, and the others by reason of a refusal, by one side or both, to consent to a council of arbitration or appointment of a referee.

"I am unable to obtain any official figures in relation to arbitration for the past year; but in his report to the Minister of Commerce and Industry, the director of the Office du Travail states that up to the time of writing—September 1, 1894—the recourse to the law had been larger, in proportion to the number of strikes, than during 1893.

"CHARLES W. WHILEY, JR., *Consul.*

"ST. ÉTIENNE, December 6, 1894."

THE UNITED STATES ARMORED CRUISER "MAINE."

THE act of Congress authorizing the construction of the armored cruiser *Maine* was passed on March 3, 1887, so that this vessel is among the first of the armored ships that were authorized to be constructed for the new navy. Together with the *Texas* she has been built at the Government yards—the *Maine* being built at Brooklyn and the *Texas* at the Norfolk yard. On page 124 we give a reproduction from a photograph of the vessel, taken shortly after she had been placed in commission.

The vessel is described in the reports of the department as a "steel-armored cruiser with two steel barbette turrets;" the length on the water-line is 318 ft., the breadth, 57 ft., with a mean draft of 22 ft. 6 in., and a displacement of 6,648 tons. The engines are of the vertical twin-screw triple-expansion type, and are capable of developing 9,000 H.P., and the calculated speed was placed at 17 knots.

As already intimated, the vessel is constructed of steel throughout except in those portions where some other material was especially specified, and great pains were taken that everything used about the hull and the fittings was of the best possible description, and that all wood used was thoroughly seasoned. The keel, which was laid in 1888, is formed, in its vertical portion, of plates weighing 20 lbs. to the square foot, and extends continuously throughout the length of the vessel; in the central portions—that is to say, between frames 12 and 74—it is $36\frac{5}{16}$ in. high. The flat keel is made of two thicknesses of plate, the outer weighing 25 lbs. and the inner 20 lbs. per square foot. The stem is of cast steel, made in two pieces, and is well supported for ramming by attachment to the protective deck and special strengthenings. The bow is strengthened by a horizontal ram plate 3 in. thick. The stern post is also of a steel casting, and, like the stem, it is made in two pieces. The upper piece is 3 in. thick, the lower end being secured to the protective deck armor, while the upper end is connected to the plating of the main deck. Cast steel is also used for the rudder and the struts carrying the shafts.

The vessel is divided into 15 water-tight compartments formed by 12 transverse bulkheads and one longitudinal bulkhead separating the engine-rooms. The transverse bulkheads are connected to the inner bottom and to the outside plating as well as to the longitudinal bulkheads by a single angle bar 3 in. × 3 in., weighing 7 lbs. to the foot. All of these bulkheads were carefully caulked and made water-tight. The same treatment was given to the magazines, light-boxes and trunks to the same, which were considered as water-tight compartments. For a length of 180 ft. amidships there is a belt of vertical steel armor extending from 3 ft. above the load water-line to 4 ft. below it, with a thickness of 12 in. from 1 ft. below the water-line to the top of the armor. From 1 ft. below the water-line to the armor shelf the thickness is tapered down to 6 in. in thickness. The top of the armor is rabbetted to receive the top plates of the berth deck armor. This armor is held in place by bolts that range from $4\frac{3}{4}$ in. to 4 in. in diameter. It is backed by 8 in. of wood that is secured to the skin plating by bolts $1\frac{1}{4}$ in. in diameter. The conning tower is built of steel 10 in. in thickness, and is elliptical in shape. It is connected with the armor deck by an armored tube $4\frac{1}{2}$ in. thick.

The ship is fitted with two revolving turrets placed *en echelon*. They are each equipped with two 10-in. guns which are placed at sufficient height to fire over the main deck. The guns of each turret can be fired simultaneously on a line parallel with the centre line of the ship, and they have an unobstructive fire on one side of 186° and on the other of 55° for the forward turret and 49° for the after turret. Each turret is protected by 7 in. of steel armor, the gun plates being of the same thickness. It was the original intention to use 10 in. in thickness for the armor of the turrets. All of the revolving parts of the turret are protected by a fixed barbette which has a steel armor 12 in. thick.

As in all of the other vessels that have been designed for the Navy, pains have been taken that the quarters for the officers and crew should be made as comfortable as possible, especial attention being paid to the methods of ventilation. The fore-and-aft bulkheads of the ward-room are made of sycamore veneered on white pine and given a dead finish. Seasoned white pine was used, however, for the athwartship bulkheads of these rooms. The state-rooms for the admiral and the captain are fitted in the same way.

The following is the list of boats that are carried: There is one 33-ft. steam cutter, one 28-ft. steam cutter, one 32-ft. sailing launch, one 30-ft. cutter, one 30-ft. barge, one 28-ft. cutter, two 29-ft. whale boats, one 28-ft. gig whale boat, one 20-ft. dingy, and two 63-ft. torpedo-boats, with all of the necessary fittings, the engines for which were illustrated in our issue of October, 1894; and the vessel itself will form the subject of a future illustration in this paper.

Communication between all of the important points of the vessel is provided for by the usual means of speaking-tubes, telephones and electric signals.

The engines are of the triple-expansion type and do not differ in their general design from the other engines that are used in the vessels of the navy, some of which are already familiar to the readers of this journal. The only features of any account that mark these engines are that while they are designed as triple-expansion engines they can be so disconnected as to be run as a compound, thus effecting a saving of coal and permitting a lower steam pressure to be carried at the same time. Then the valves are operated through a rocker arm instead of being directly connected, as is usually the case. The engines are built as rights and lefts, and are placed in separate water-tight compartments that are separated by a fore-and-aft bulkhead. They are of the vertical inverted cylinder direct-acting triple-expansion type, each having a high-pressure cylinder $35\frac{1}{2}$ in. in diameter, an intermediate cylinder of 57 in. diameter and a low-pressure cylinder of 88 in. diameter; the stroke of all of the pistons being 36 in. The collective I.H.P. of the propelling engines, air-pump and circulating-pump engines is 9,000 when the main engines are making about 132 revolutions per minute. All of the cylinders of the main engine are steam jacketed, and they are arranged with the high-pressure cylinder of each aft and the low-pressure forward, and it is the latter that is disconnected when working at a low power. The main valves are of the piston type, worked by Stephenson links

of the double-bar type. In the construction of the engines, the piston valves, valve liners and valve gear were made interchangeable. There is one piston valve for each high-pressure cylinder, two for each intermediate cylinder, and three for each low-pressure cylinder. The framing of these engines consists of hollow cast-steel columns trussed with wrought-iron stays. The engine bed-plates are also of cast steel, and are supported directly upon the keelson plates that are built into the vessel. The crank shafts are made in interchangeable sections, and all of the shafting is hollow.

The condensers are made entirely of composition and sheet brass, and each one contains a cooling surface of 7,010 sq. ft., measured on the outside of the tubes, the water passing through the tubes. Each propelling engine is provided with a double, horizontal, double-acting air-pump worked by a vertical compound engine. The circulating pumps are of the centrifugal type, and are worked independently for each condenser. The propellers are three-bladed, and are made of manganese bronze.

The boiler capacity is made up of eight single-ended steel boilers of the horizontal return fire-tube type, 14 ft. 8 in. outside diameter and 10 ft. long, constructed for a working pressure of 135 lbs. per square inch. They are placed in two equal groups, with fore-and-aft fire-rooms. Each has three corrugated furnace flues made by the Continental Iron Works, of Brooklyn, N. Y. These flues are 3 ft. 6 in. in diameter. The total heating surface of all of the boilers is about 18,800 sq. ft., measured on the outside of the tubes; and the grate area is about 553 sq. ft., giving a ratio of about 1 to 34. Each boiler compartment is provided with a vertical duplex main feed pump and a duplex auxiliary feed pump, each of these pumps being complete in itself.

The forced draft in each compartment consists of two blowers, which discharge into a main air duct under the fire-room floors, from which a branch duct leads to the ash-pit of each furnace. Means are also provided for closing the ash-pits when under forced draft for preventing the leakage of gases out of the furnace doors. The draft of each furnace is further regulated by an independent damper for each one.

The ship is provided with the usual equipment of steam reversing gears, ash-hoists, turning engines, auxiliary pumps, engine-room ventilating fans, a combined windlass and capstan, steam winches, a steering engine, engine and dynamo for working various small machinery and for lighting the engine and fire-rooms, a hydraulic pumping plant for various purposes, turret-turning engines, a distilling apparatus, as well as other minor pieces of supplementary machinery, tools, etc.

As we have already said, the crank shafts of the two engines are interchangeable. They are 7 ft. 9 in. long over all and are fitted with a bearing on each side of each crank that is 13 in. in diameter. This shaft is increased to a diameter of 13½ in. at the eccentric seatings. The crank-pins are 14 in. in diameter and 14 in. long, and the webs are 17½ in. wide and 9 in. thick. A 4-in. hole is bored through each shaft and crank-pin, which are set at angles of 120° with each other, the high-pressure crank leading, followed by the intermediate and the low pressure in the order named.

There are two gears for revolving each turret, each consisting of a three-cylinder hydraulic engine, driving a pinion and spur on a horizontal shaft which carries a bevel wheel meshing into a rack on the under side of and revolving the turret. The engines have been so designed that each has the power to turn the turret at the rate of one revolution per minute with the guns run out and the vessel on an even keel, while the two together have the power to revolve the turret at the same speed with the vessel heeled 10°. In general method of operation these engines are similar to those that were illustrated in the April, 1894, issue of THE AMERICAN ENGINEER AND RAILROAD JOURNAL—that is, they are started, stopped and reversed by a valve which changes the pressure and exhaust ports. There is also a hydraulic locking device for each turret consisting of a cylinder, plunger and locking bolt with the necessary valve gear.

The armament of the *Maine* consists of four 10 in. breech-loading rifles, six 6-in. breech-loading rifles. The secondary battery consists of eight 6-pdr. rapid-fire guns, eight 1-pdr. rapid-fire guns and four Gatlings.

The vessel is now in commission; but the two large torpedo boats that are intended to be carried upon her decks are not yet on board. One is ready for delivery, however, and the other will be finished in a few days.

The engines were built by the Quintard Iron Works, of New York, and are considered by the officers of the Engineering Department as being remarkably fine specimens of engine designing and construction. The contract called for the construction of engines that should develop 9,000 H.P., and this was exceeded in the trials by 171.45 H.P., as shown by the abstract of the official report that is given below:

DATA OF OFFICIAL TRIAL, U. S. "MAINE."

Draft of water at beginning, forward	18 ft. 2 in.	
" " " " " aft	19 ft. 1 in.	
" " " " end, forward	17 ft. 10 in.	
" " " " " aft	18 ft. 11 in.	
" mean, for trial, forward	18 ft.	
" " " " aft	19 ft.	
Displacement at mean draft on trial	5,500 tons.	
Area of midship section at 18 ft. 6 in. mean draft	906 sq. ft.	
Wetted surface	21,850 sq. ft.	
I. H. P. (total) per 100 sq. ft. of wetted surface	42 53	
" per 100 sq. ft. of wetted surface at 10 knots in ratio of 3.5 power	6.0142	
Mean speed	17.45 knots.	
Slip of screws, mean, starboard	12.805 per cent.	
" " " " port	10.205 per cent.	
Speed^3 × area immersed midship section ÷ I.H.P	518.26	
" ^{3} × displacement ⅔ ÷ I H.P	165.21	
Temperatures in degrees Fahr., injection		63.
" " " " discharge	114.	99.5
" " " " hot well	127.3	127.3
" " " " feed	127.3	127.3
" " " " engine rooms, upper	146.	
" " " " " " lower	99.	
" " " " fire rooms, forward	127.	
" " " " " " aft	134.	
Revolutions of blower per minute, main boilers	450.	
Air pressure in in. of water, ash pits	1.074	
" " " " " " furnaces	.92	
H.P. cylinder, mean pressure	54.372	53.656
I.H.P	1,216.89	1,165.56
I P. cylinder, mean pressure	20.907	19.597
I.H.P	1,218.35	1,108.94
L P. cylinder, mean pressure	16.236	16.267
I.H.P	2,261.75	2,200.00
Aggregate equivalent mean pressure on L. P. piston	33.7175	33.0855
I.H.P. collective of each main engine	4,696.95	4,474.50
" " " both " engines	9,171.45	
" of combined air and circulating pumps	28.25	24.593
" collective of " " " " (2)	52.843	
" of all forced draft blowers (4)	38.068	
" " main feed pumps (2)	15.429	
" " other auxiliaries	14.856	
" " all auxiliaries	121.1962	
" each main engine, air and circulating pump	4,725.20	4,499.093
" both main engines, air and circulating pumps	9,224 293	
" total of all machinery in use	9,292.646	
Indicated thrust (I.H.P. main engines)	57,354.40	
" " per sq. in. of surface of thrust bearings	59.31	
Cu. ft. swept per minute by L.P. piston, per I.H.P. of main engines	6.73	6.87
Sq. ft of H. S. per I.H.P	2 0462	
" " cooling surface per I H.P	1.5087	
I.H.P. of all machinery in operation, per sq. ft. of G.S	16.1938	
I.H.P. per ton of propelling machinery, boilers and water	14 18	

Coal Consumption.

Sq. ft. of G.S. in use	573.84
" " H.S. in use	19,015.36
Kind and quality of coal used	Pocahontas, good quality.
Coal burned per hour, actual weight	20,272 lbs.
" " " " per sq. ft. of G.S	35.327 lbs.
" " " " " " " H.S	1,066 lbs.
" " " " " I.H.P. of all machinery	2.1815 lbs.
" " " " " " " main engines, air and circulating pumps, and feed pumps	2.194 lbs.

An examination of the above table will show that the contract speed was exceeded by 0.45 knot. The only thing about the vessel that has excited adverse criticism is the high temperature of the engine and boiler rooms. A temperature of 146°, like that which prevailed in the upper engine room, is certainly too high for long-continued or violent exertions, while 134° is more than firemen can endure and work the boilers to advantage. It seems that the hatch from which the hot air from the engine-room has to escape measures 4 ft. × 8 ft., and that something more than one-half of the area of this hatch is blocked by an armored grating. This is, however, a matter that can probably be remedied by the use of exhaust fans or other methods of artificial ventilation. In other respects the vessel has more than come up to the expectations of the designers as laid down in the specifications.

THE GAS-MOTOR STREET CAR IN SERVICE IN GERMANY.

OUR consul in Frankfort, Mr. Frank H. Mason, under date of November 30, 1894, has made the following supplementary report on the gas-motor street cars used in that country. He says:

"In two previous reports of this series * some account was given of a new method of propulsion for street and suburban railway cars, by means of a gas engine, as first applied and put in operation at Dresden, and subsequently introduced

* See AMERICAN ENGINEER AND RAILROAD JOURNAL for March, 1894, and October, 1894.

experimentally into Great Britain. The earliest models of this car were unduly heavy, complicated and expensive; but it has since been improved and simplified to a point of economy and efficiency which it is now thought may fairly challenge expert criticism. At the beginning of August last four cars of the latest and most improved type were put into regular service upon a suburban railway leading from Dresden along a busy boulevard to the village of Wilden Mann, a distance of nearly 3 miles. These cars have since been in daily service from six o'clock in the morning until ten at night, working side by side over part of the line with horse cars, with which the road was originally equipped, so that a close temporary comparison is offered between the two systems, operated under identical conditions.

"With the exception of some slight modifications, designed to minimize the oscillation of the vehicle at the moment of starting or when at rest with the engine in motion, these cars are of the same general type as the one described in the last previous report as being in experimental service at Croydon, in England.

"Outwardly the car's appearance is precisely similar to that of an ordinary double-decked horse car, having stairways from each platform to the seats on the roof. All the machinery is inclosed and concealed from sight; there is no smell of gas, no noticeable heat from the engine, and no undue noise or jar when the car is stopped or set in motion. The motor is a double-cylindered gas engine of the Otto model, placed under the seat at one side of the car, and reached for purposes of oiling, cleaning, or repairs by doors which form panels in the outer wall of the car, and when closed are not noticeable. The engine is of the latest type, in which the gas is ignited at each stroke by an electric spark from a small battery located in the engine space, so that the car is put into or out of service by turning a knob, which opens or closes the circuit.

"The engine is kept in motion while the car is in service, and the whole is managed by the driver, who, standing on the front platform, has within reach the brake wheel, on which is fixed the alarm bell and a movable lever which, when in an upright position, leaves the engine disconnected with the running gear of the car and cuts off the gas supply so that but one explosion takes place in one of the cylinders at each eighth revolution, the motion of the engine being meanwhile maintained and steadied by the fly-wheel, which is 4 ft. in diameter and of corresponding weight. When the lever is pushed to the left, it turns on a two thirds supply of gas in both cylinders and brings into engagement a friction clutch which connects the engine shaft with the wheel axis and gives the car a speed of 4½ miles per hour. Pushing this lever to the right turns on the full gas supply and brings into connection a friction clutch of larger diameter, which gives the car a speed of 9 miles per hour. A second lever is provided for reversing the engine and direction of movement.

"The gas supply is carried in three cylindrical reservoirs of boiler iron about 10 in. in diameter, two of which are hung transversely under the floor at each end of the car, while the third is placed beneath the seat at the side opposite the engine. The weight is thus to some degree equalized. The three reservoirs weigh together about 550 lbs., and contain 33.5 cub. ft. of gas, condensed to a pressure of eight atmospheres by means of an ordinary force pump at the end supply station. This pump is worked by a gas engine of 8 H.P. The whole apparatus costs, in Germany, $2,380.

"A fourth cylindrical reservoir, containing water for cooling the engine cylinders, is placed beneath the double seat along the middle of the deck roof, whence the cool water descends and the warm ascends automatically through concealed copper tubes, so effectively that the water, being continually cooled in the exposed reservoir, is used over and over again, and keeps the cylinders down to the requisite temperature. The gas reservoirs are filled at the end station by means of a flexible hose leading from the condenser, and the filling process occupies from 30 seconds to a minute, according to the calibre of the hose and the degree to which the gas in the reservoirs has been previously exhausted.

"The ordinary car is equipped with a gas engine of 9 H.P., and carries 36 passengers—viz., 14 seated inside and 12 on deck, with platform standing room for 10 more. The car costs, in Germany, 12,000 marks ($2,856). When it is desirable to make the motor car capable of drawing a trailer during hours or days of increased travel, the engine is increased to 12 H.P., and the car then costs, complete, $3,094. The work of the new motor cars, which have now been in service at Dresden during a period of three months, seems to have fulfilled substantially all that has been claimed in their favor. The car is perfectly manageable, stops from full speed within its own length, starts without noise or shock, is free from heat or smell, runs as smoothly as a horse car on what would be considered in America a rather rough and poorly constructed track, far surpasses a horse car in speed when the way is clear, and is handled safely and easily on a boulevard which at certain hours is crowded with traffic that renders frequent and sudden stops necessary. At the slower rate of speed it mounts a grade of 1 in 22, and traverses uphill a curve of 40 ft. radius.

"Exact and conclusive comparisons of net cost and operating expenses, as compared with other systems of propulsion, can, of course, be deduced only from prolonged and continuous service covering a period of years, but from the experience thus far gained, some of the essential factors of the problem may be closely approximated. Gas is furnished by the street gas company in Dresden at its usual rate, 3 cents per cubic metre, or about $1.05 per 1,000 cub. ft. At this price, the cost for gas consumed by a car in service is 1 cent per car kilometre (1⅝ cents per car mile). The initial cost of a gas motor car does not differ much from that of a new horse car with its complement of horses. The gas reservoir station for a large line occupies but small space, and can be managed by one or two men, and the cars, when not in service, consume nothing and only require a shed for shelter from the weather. One cleaning per week is found to be sufficient for the machinery, which is tightly inclosed and protected from dust and dampness.

"In Germany, good horses for tramway service cost from $200 to $250 each, and their average efficiency does not exceed three years, at the end of which time they are either worn out, or, if salable for breeding purposes or farm work, they bring only from one-fourth to one-half of their original cost. In Dresden the annual depreciation of street-railway horses from all causes—disease, accident and inevitable wear from hard service in all weathers on hard pavements—is reckoned at from 18 to 22 per cent. of their value, and this percentage is said to be still higher in tropical or very cold countries, where only inferior breeds of draft horses are available and the conditions of animal life are less favorable.

"The cost of keeping a gas motor car in repair, although not yet fully demonstrated for a long period, is estimated at not more than 5 per cent. annually of its original cost, and with ordinary care such a car should last as long as two or three outfits of horses, which latter are, moreover, subject to epidemics and to conscription, in case of sudden war, for military service. So far, therefore, as experience has yet demonstrated, the mechanical efficiency of the gas-motor car would seem to be assured; and a comparison of its cost of construction and operation with the known expense of working horse, cable, steam, and electrical tramways in the United States can hardly fail to invest the new motor, as a competitor in the same field, with a serious practical interest. Further improvements will, no doubt, still better adapt it to its work under varying local conditions, but in its present form it would not seem to be well suited to lines which have grades more abrupt than 1 in 20, and it has not yet been proven to be well adapted to countries which are subject to frequent and heavy falls of snow.

A NEW CAR FOR THE UNITED STATES.

"In the latter of the two previous reports on this subject, it was stated that a gas-motor car of the most improved type was then under construction in England, and would be sent to the United States for trial and exhibition in October. In order to adapt the invention more fully to the peculiar requirements of our country, a second and entirely new model has been invented, with the result that the contemplated exhibition in the United States has been unavoidably postponed until some time in February.

"The fact has been taken into account that in a country where sudden and frequent snow falls occur in winter, a motor of higher power is requisite, and that in order to meet more fully the wants of American tramway companies, the machine must be so modified as to be readily applied to cable, electrical, and horse cars already in use, thereby economizing all but the running gear of such vehicles. The following modifications have therefore been made in the Dresden model as above described: The motor has been condensed in compass so as to be readily set upon a four-wheeled truck, wholly independent of the upper portion of the car. The fly-wheel and driving machinery are laid in a horizontal position between the wheels, and two sets of springs are provided, those supporting the machinery resting directly on the axles, and those supporting the car body bearing on the truck frame, the two sets of springs being entirely independent of each other. By this clever device the vibration caused by the engine at the moment of starting is reduced to a minimum, and the whole apparatus so simplified that when the body of any ordinary street car is bolted to the springs and the cool-

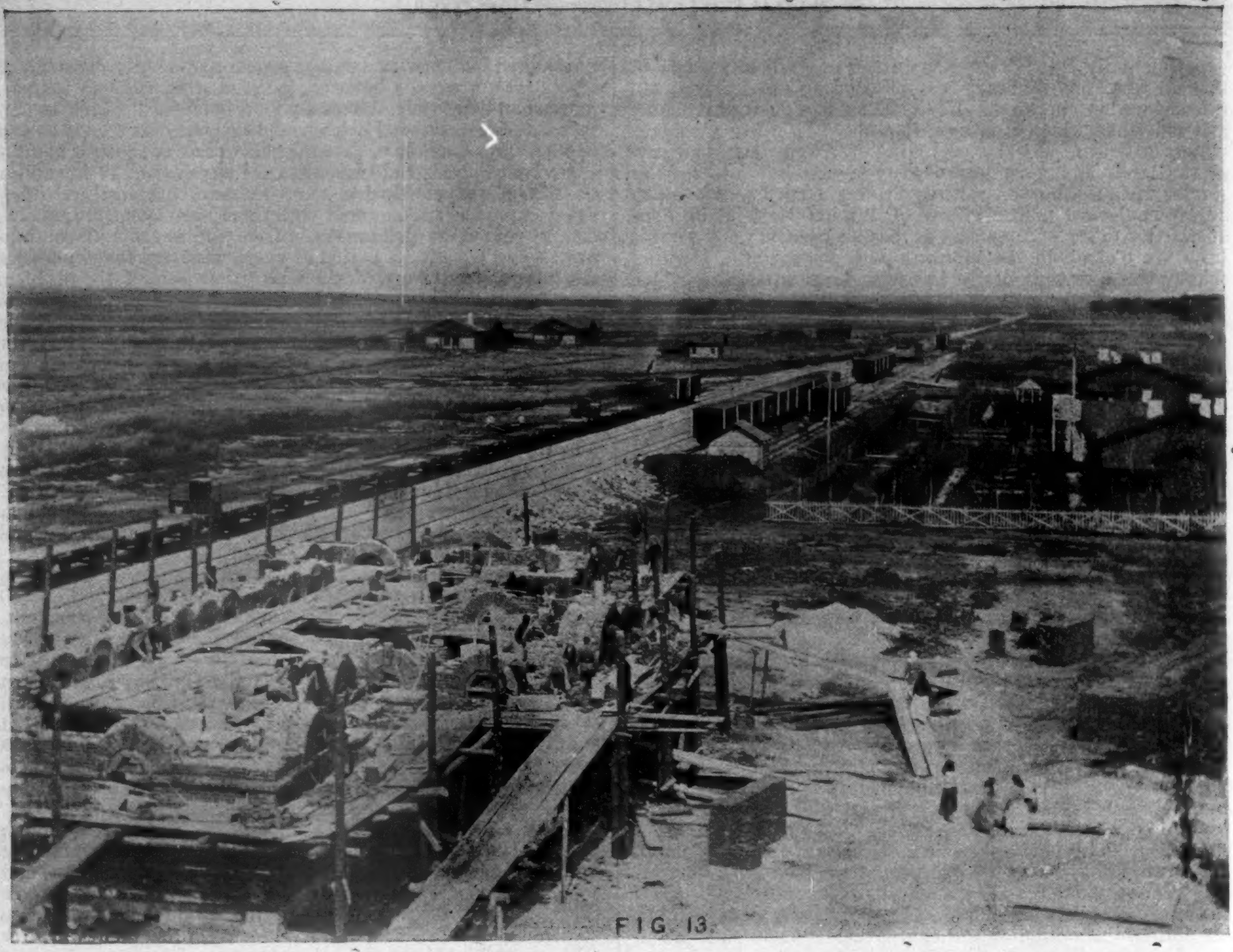


FIG. 13.

FIG. 14.

VIEWS ON THE WESTERN SIBERIAN RAILWAY.

water reservoir and its connecting pipes are attached, the car is ready for service. The motor has been increased from 8 H.P. to 20 H.P., and its maximum speed, with the larger friction clutch in engagement, to 12 miles an hour.

"Thus, within less than a single year after having first been put in operation, the Lührig gas-motor car has been so modified and improved as to constitute a practically new machine, in which all the mechanical and economic difficulties which were at first encountered seem to have been successfully overcome. "FRANK H. MASON, *Consul-General.*

"FRANKFORT, November 30, 1894."

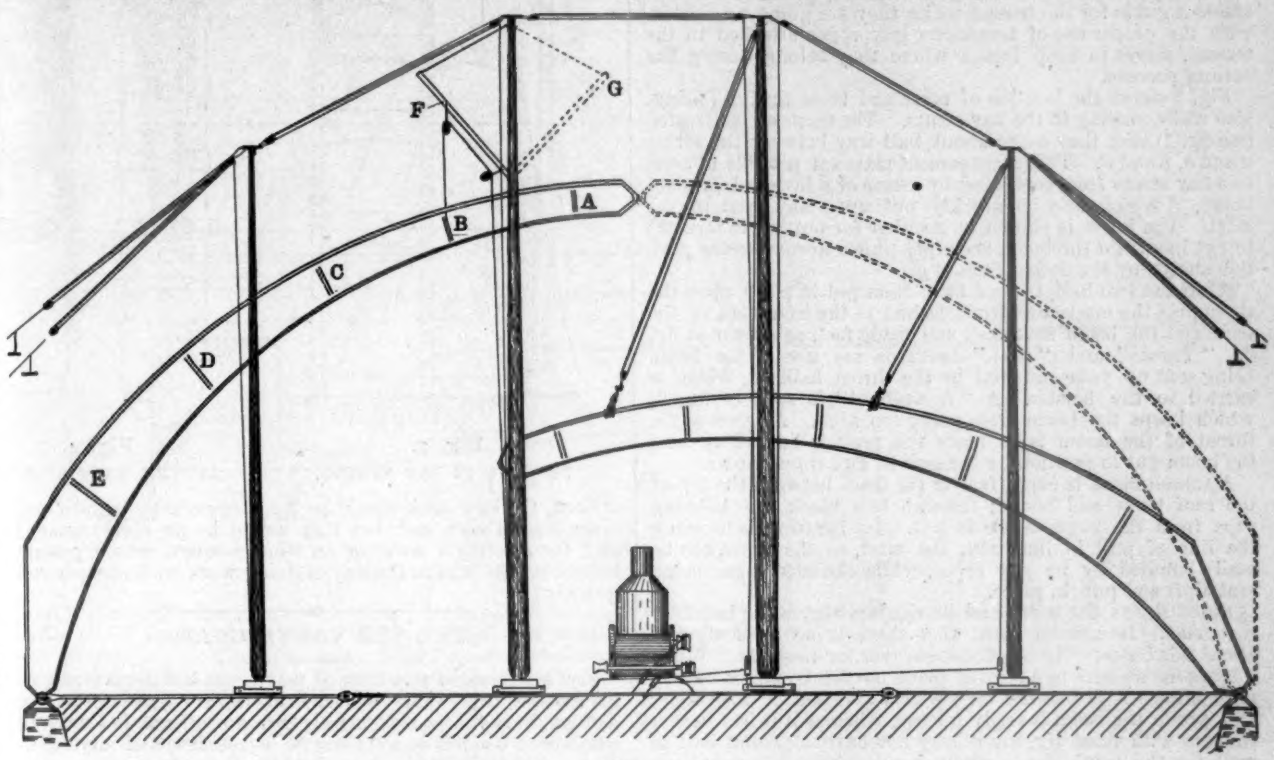


Fig. 1.

MAST TRAVELLER FOR ERECTING ROOF TRUSS.

VIEWS ON THE WESTERN SIBERIAN RAILWAY.

THE two views, figs. 13 and 14, herewith complete our series of illustrations on the line of this great work. Fig. 13 represents a general view of an incomplete station at Kourhan, and gives a very good idea of the character of the country and of its resemblance to our Western prairies. The view of the incomplete foundations also shows that the Russians are doing some very substantial work.

Fig. 14 is a number of sledges loaded with barrels of tallow and drawn by camels at a station in Kourhan. Most people in this country have an idea that a camel is an animal adapted to warm climates only. Our view and the testimony of travellers in Russia show that they are adapted for service in countries where snow falls and sledges are used.

MAST TRAVELLER FOR ERECTING HEAVY WORK.

BY JAMES F. HOBART.

FRAME travellers for erecting heavy trusses and iron buildings in general are expensive tools to handle and to build In order to be satisfactory, a frame traveller must be stiff, well built, contain a large number of devices for handling, raising and conveying material, and it must be mounted upon car wheels and railroad iron or some other stiff form of metal.

To construct, operate, remove and transport the traveller and its accompanying material will cost a large percentage of the amount allotted to erection of the iron-work.

In the erection of the large trusses which form the roof of the drill shed of the new Fourteenth Regiment Armory at Eighth Avenue and Fifteenth Street, Boooklyn, no frame traveller was used, the entire job being done in a most expeditious manner by the use of a four-mast traveller, as shown by fig. 1. The truss roof is composed of 12 steel arches, covering an area of 195 ft. 4 in. wide, by 260 ft. $\frac{1}{4}$ in. long. Each truss has a span of 195 ft. 4 in., and weighs about 70,000 lbs.

The outside radius of the roof arch is 114 ft. $2\frac{11}{16}$ in. The inside radius, 95 ft. $3\frac{23}{32}$ in.; the vertical height of truss is 80 ft., leaving 75 ft. clear from floor to roof. Twenty-five ft. vertical height is left on outside of the arch, and radii drawn from these points subtend an angle of 152° 55′ 10″, the truss forming a true circle for that distance on angle. The inner sweep forms a true circle through 117° 32′ 32″.

The trusses were constructed by the Elmira Bridge Co., and erected by Milliken Brothers, who hold the contracts for the structure. Expansion is amply provided for, each half truss being hung upon a steel pin $4\frac{5}{16}$ in. in diameter, except one truss at each end of the shed, which has 5-in. pins and is tied together by rods 2 in. square, two being used to each truss. The inside trusses are supplied with $1\frac{1}{8}$-in. rods. Each arch truss is built in two pieces, and is hinged together at the top by a $4\frac{5}{16}$-in. pin. This form of construction allows of perfect expansion adjustment. Each pair of arches is connected together by four steel struts, making 13 bays; the ends of struts in end bays being built solidly 12 in. into the brick end walls of the building.

Three expansion bays, one the second from each end, the third in the middle, take care of the variations of heat and cold. The struts are put up with $\frac{11}{16}$-in. rivets; but the expansion bays have holes slotted to $\frac{11}{16} \times 1\frac{1}{2}$ in., and $\frac{7}{8}$-in. bolts are used in the erection.

The steel arches are built up in sections of a size to be easily handled by teams, and are completed in the building, each half truss (see fig. 1) being put together complete and riveted throughout while lying on the ground. Each part of the truss can thus be put in place while it is lying on the ground, and every rivet driven except those which hold the bay struts in place.

For erecting the trusses the four-mast traveller shown in fig. 1 is used. The two outside masts are each 85 ft. high, the two central masts 104 ft. They are stayed and guyed as shown, being connected to each other by tackle controlled by ropes leading to the base of each mast.

Two end guys lead from the top of each end mast, and are made fast to ground anchors buried about 30 ft. apart and located in the strut 90 or 100 ft. from the base of the outside masts. These guys are each attached to a threefold tackle

at the top of each mast, the rope from each tackle leading to and being made fast at the base of each mast; two side guys to each mast were also attached and made fast. These guys may be seen in fig. 2.

The engraving (fig. 1) shows very plainly the arrangement of the masts and guys. It also shows one-half of a truss in position, the other half being in the act of being raised, power being supplied for all hoisting by the three-drum hoisting engine shown in the middle of the engraving. The row of masts are so set and located that the trusses shall bear against and slide up their sides during the raising process; this furnishes a guide for the trusses while they are going up. This, with the proper use of temporary guy ropes attached to the trusses, serves to keep things where they belong during the raising process.

Fig. 2 shows the location of mast and truss during raising, also while putting in the bay struts. The masts are so located (see fig. 1) that they come about half-way between the struts *a* and *b*, *c* and *d*. This arrangement makes it possible to erect two bay struts from each mast by means of a little independent boom, *f*, which may be quickly put upon any part of the mast. The boom is shown in position for putting in strut *b*; to put in strut *a* the boom is simply pulled around to the position shown by the dotted lines at *g*.

After the two half trusses have been put in place upon the three pins the masts are firmly lashed to the iron-work of the truss and the boom sent aloft and made fast, as shown in fig. 2. "Throat" and "peak" halliards are used; the boom being sent up yoke end first by the throat halliard, which is carried to the hoister. A "down-haul" is seen in fig. 2, which keeps the boom from going too high. As soon as the throat of the boom is in place the peak is hauled up and the boom put in position by the pair of guy ropes shown.

A snatch-block is made fast to the mast between the top of the roof truss and boom; through this block the hoisting rope from the boom tackle is put. Its function is to bring the line of pull in line with the mast, so the boom can be easily handled by its guy ropes, while the struts are being sent aloft and put in place.

Fig. 3 shows the boom and its rigging bent as for handling the struts. It will be noted that there is no fixed rigging about this boom. No eye-bolts, sheaves, or mortises. When a block is wanted in a certain place on this boom (or on the mast either) it is "seized on" with a few feet of inch rope, and, *presto*, the boom is ready for use, whereas if it had been a concern with fixed rigging it may not have answered half as well for the particular work in hand. Indeed, it may have been necessary to make a special boom, which probably would have been useless for the next job to be done.

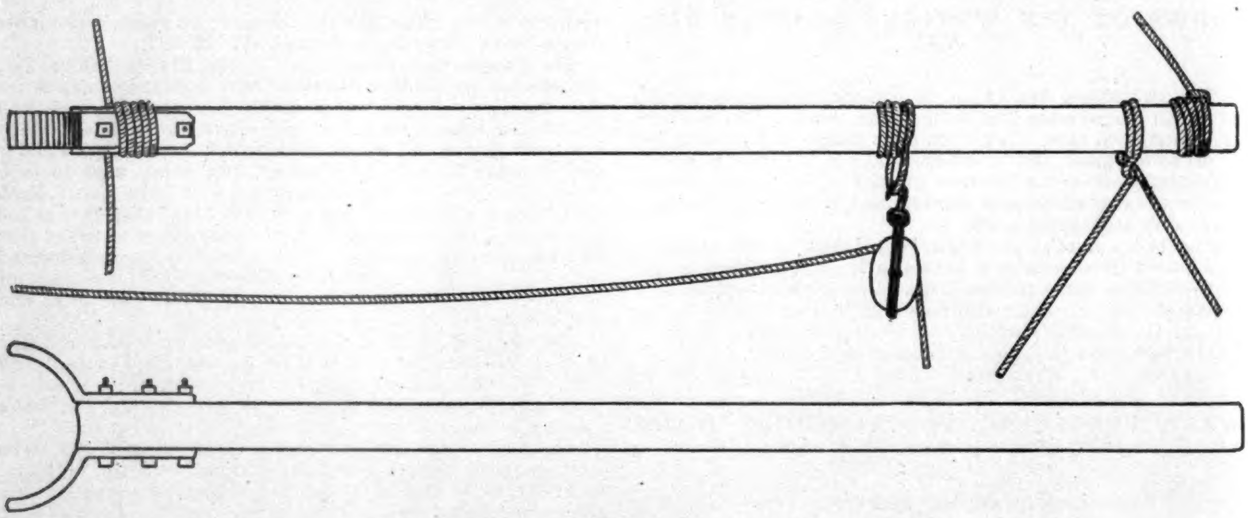


Fig. 3.

ADJUSTABLE BOOM.

A peculiarity in the two taller masts lies in the manner in which they have been spliced. Masts 104 ft. high don't lie around very plenty; and if a stick 120 ft. long was wanted it would make necessary the splicing of more timber—a slow and costly job. But, by taking off the short pieces and putting on those of the required length, the 120-ft. masts can be quickly made up.

It will be seen in fig. 4 that the splices, while much alike, are not the same on both masts. Indeed, one is male, the other female; and it is possible to put the main part of both masts together to make a stick over 180 ft. long. When thus

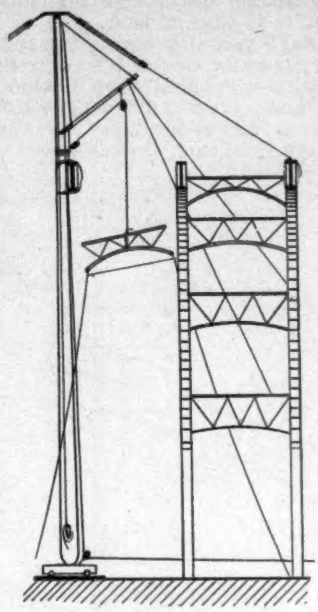


Fig. 2.

PUTTING IN BAY STRUTS.

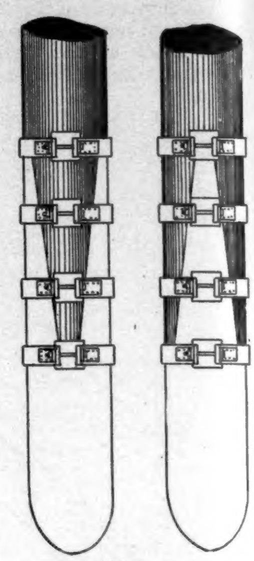


Fig. 4.

DUPLEX MAST SPLICE.

spliced, the long stick would be the biggest in the middle and taper toward each end, but that would be no disadvantage; and, for erecting a tower or an iron chimney, would possess infinite possibilities in the way of doing work well, cheaply and quickly.

THE JOY VALVE GEAR.

For some reason this form of valve gear has never met with the favor in this country which its merits seem to deserve. In Europe it has been extensively introduced, and has been in continuous use for many years on locomotive and marine engines. Possibly one reason why American locomotive engineers have not taken it up is because no simple explanation of its working and describing how it should be laid out was obtainable on this side of the Atlantic. To meet this want Mr. Joy has published a little pamphlet with the title "Rules for Laying down the Centre Lines of the Joy Valve Gear," which is now issued in a third edition. Probably most of our readers, like ourselves, have never seen a copy of these "Rules" before. Quite recently, through the thoughtfulness of Mr. Clement E. Stretton, who devotes the major part of his life in doing favors to other people, we have received a copy of this excellent little manual, which we take pleasure in reprinting

with some amplifications. Before doing this a little explanation of the general construction of the Joy gear may not be out of place. A form much used in England on locomotives is represented by fig. 1, from which it will be seen that it consists of a "*connecting link*," 1, which is pivoted to the connecting-rod 6 at e'. The lower end of the link 1 is connected to an "*anchor link*," 2, at *f*. This anchor link is attached to a fixed pin or fulcrum at f'. The main valve lever 3 is connected to the connecting-link 1 at *j*, and is fulcrumed at *m* to a block, 7, which slides vertically in a curved link, 4. The upper end *g* of this lever is connected to the valve-rod 5. The link 4 is attached to a shaft, represented by a dotted circle whose centre is at *m*. This shaft can be turned so as to bring the link into different positions of inclination, as shown by the dotted centre lines marked "forward," "middle" and "back." It is evident that as the crank revolves that the lower end of the valve lever 3 will be moved horizontally and also vertically, and will carry the block 7 with it in its vertical movement. The upper end *g m* of the lever is proportioned so that the horizontal movement of *j* will move the valve an amount equal to its lap and lead, so that when the crank is at either of its dead points the block 7 will be in the middle of the link, and the valve will then be moved so as to give the required lead opening at either end of the cylinders. It is obvious, too, that if the link is inclined the vertical movement of the block will also cause the fulcrum *m* to be moved horizontally, and that this horizontal movement will be imparted to the valve-rod and the valve. The amount of this horizontal movement will be in proportion to the inclination of the link, so that the travel of the valve can be regulated by giving the link different degrees of inclination, or it can be reversed by changing the inclination, as indicated by the dotted lines.

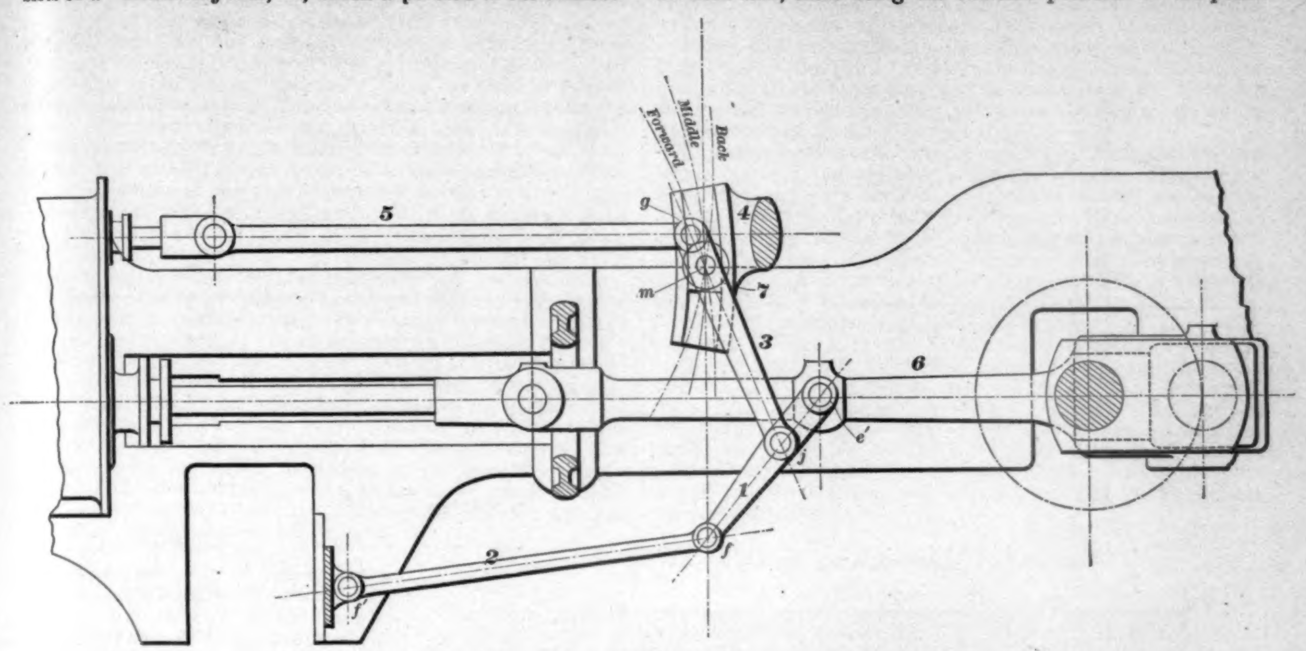


Fig. 1.
JOY VALVE GEAR AS APPLIED TO AN ORDINARY LOCOMOTIVE.

Fig. 2 represents this gear applied to a vertical overhead marine engine, the operation of which will be readily understood from the preceding description.

Now, for laying down the centre lines of this gear, Mr. Joy has given the following

RULES.

Lay down the centre line of the cylinder *a a* (fig. 3) and that of the valve spindle *b b* at the relative distances required for the engine to which the application is to be made, the valve spindle centre line being, however, in the plane of the vibration of the connecting-rod. Draw the path of the crank-pin h' c' *a* c'' and the centre lines of the connecting-rod *c* c', *c* c'' for both upper and lower positions when the piston is at half-stroke. Take a point, *d*, on the centre line of the connecting-rod, where its vibration between d' and d'' is equal to about double the length of the full stroke of the valve (it is better to allow rather more than less). It may, however, be chosen very much to suit the other arrangements of the engine, such as the position of the slide-bar brackets, etc., getting, however, if possible, a vibration of the connecting-rod fully equal to double the stroke of the valve, to avoid too great an angle of the slide link when angled for full forward or backward gear.

Having chosen the point *d*, draw a vertical line, *s* s', through it and at right angles to *a a*, and mark off the two points *e* e' on each side, these being the extreme positions of the point *d* on the connecting-rod for front and back stroke; from these points draw lines to a point, *f*, on the vertical, so far down that the angle between them shall not be more than 90°; less is better, if there is room to allow of it (these will represent the centre lines of the "*connecting link*" marked 1, pinned to the connecting-rod in figs. 1, 3 and 4). The point *f*, which will rise and fall with the vibration of the connecting-rod, is to be controlled as nearly as may be on the vertical line by a link pinned either forward near the cylinder at f', or, if more convenient, it can be pinned backward near the crank. This link,

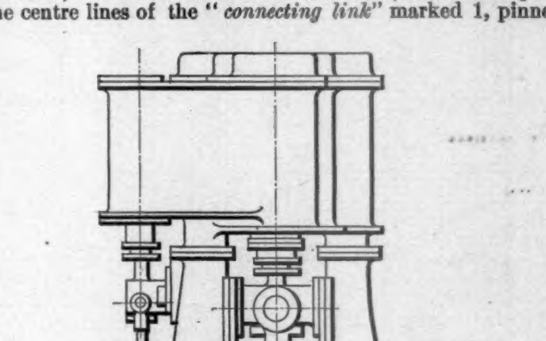


Fig. 2.
JOY VALVE GEAR APPLIED TO OVERHEAD MARINE ENGINE.

which is called the "*anchor link*," is marked 2 in the same figures, or the point *f* may run in a slide, see *f'''*, fig. 4.

Next, on the valve spindle centre line *b b*, mark off on each

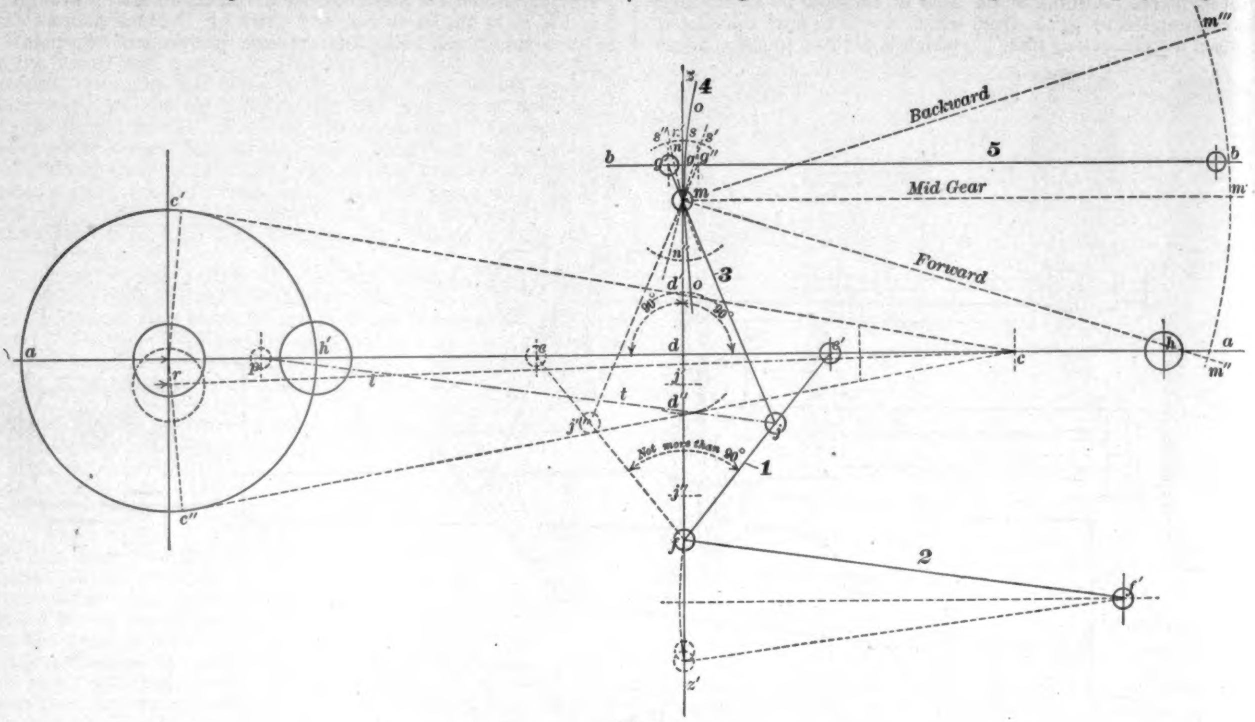


Fig. 3.

DIAGRAM FOR THE CONSTRUCTION OF THE JOY VALVE GEAR.

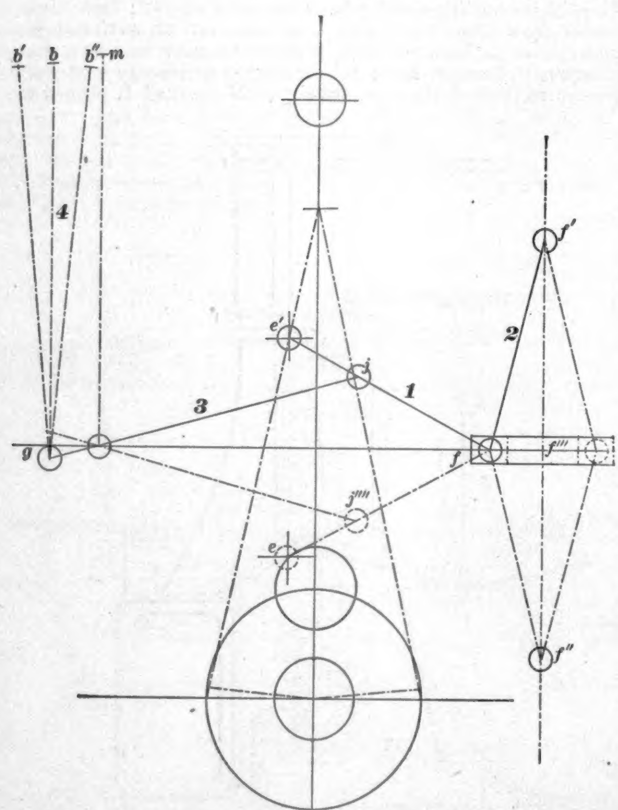


Fig. 4.

DIAGRAM FOR THE CONSTRUCTION OF THE JOY VALVE GEAR.

side of the vertical *z z* the amount *g g'* and *g g''* required for lap and lead, the one *g g'* being "lap" and "lead" for the front end of the cylinder, and *g g''* being "lap" and "lead" for the back end of the cylinder. Then, assuming the piston to be at the front of the cylinder, and the centres of the connecting-rod to be at *h h'* (*h'* being the crank-pin), the point *d*, which we have chosen to take motion from, will be at *e'*, and the connecting-link pinned to the connecting-rod for transmitting motion to the valve lever 3 will be at *e' f*. From a point, *j*, on this link, whose distance from *e'* has at first to be assumed, and will be about one-third more than *d' d*, the half vibration *d d'* of the connecting-rod, draw the centre line of the lever 3 (see also figs. 1 and 4), actuating the valve, that is, joining *j* and *g'*; the point where this line crosses the vertical *z z'* will be the centre or fulcrum of the lever 3, and will also be the centre of oscillation of the curved links 4 (fig. 1), in which the blocks carrying the centre of the lever slide; this centre is marked *m*, and stands for both centres, which must be concentric at each end of the stroke. The function of the link *e' f*, and the attachment of the valve lever to it at *j*, is to eliminate the error in vibration of the lever centre *m*, which would otherwise arise, from the fact that the path through which the lower end *j* of the lever 3 moves is an arc of a circle about the fulcrum *m*, and not a straight line. As the link 1 vibrates about the pivot *e'*, the point *j* also describes an arc of a circle about *e'* as a centre. The position of these two arcs is reversed in relation to each other, and thus the movement of the link 1 neutralizes the error due to the movement of the lower end of the lever 3. Although the position of the point *j* may be found by calculation, it is much more quickly found by a tentative process, and to test if the assumed point *j* be the correct one, we mark off on each side of *m* vertically the correct equal vibration *m n'* and *m n''*, required, which will be the same as the vibration *d' d''* of the connecting-rod on the vertical line *z z'*. Then from *d'*, the intersection of the centre line of the connecting-rod, when it is in the position *c c'* with the vertical line *z z'*, lay off a distance, *d j*, equal to *e' j* on the vertical *z z'*, and from *d''*, the intersection of the centre line of the connecting-rod, when it is in the position *c c''* with the vertical *z z'*, lay off a distance, *d'' j''*, also equal to *e' j*. Then, if the length *j m* be applied to *j' n'* (measuring from *j'*) and to *j'' n''* (measuring from *j''*) and the point *m* fall below *n'* and *n''* in each case, it will be necessary to take a point on *e' f* higher than *j*; or if, on the other hand, *m* falls above *n'* and *n''*, then a point must be taken on *e' f* lower than *j*. This point will generally be found on a second trial, but the length *j m* of the lever *j m g'* must be such that its centre *m* vibrates equally above and below the centre of the quadrant, also marked *m*.

The point *m*, as said, now represents the centre of oscillation for the curved links 4 and the centre or fulcrum of the lever 3. And these, as already said, must coincide, when the piston is at each end of the stroke, the lead being then fixed, and the curved links can be pulled over from forward to back-

ward or any point of expansion without altering the lead. This may be taken as a test of the gear being set out correctly.

The point g will be the point of attachment for the valve spindle link marked 5 (see also figs. 1 and 2), which may be made any convenient length, but from that length as a radius the curve of the links must be drawn from a centre, m', on the parallel line $m\ m'$; the angle at which this curve is set from the vertical (which is mid-gear) will give forward or backward gear—the angle leaning forward s', or to the front of the engine, being forward gear, and the reverse s'' being backward gear. The centres for these curves will be found at m'' and m'''. The amount of the angle marked on the curve of extreme vibration at $s\ s'$ or $s\ s''$ will be equal to one-quarter more than the full opening of the port at that angle (that is, if 1" opening of port be required, then the amount of the angle $s\ s'$ must be 1¼"), and the point of cut-off will be about 75 per cent. Laid out in this form the "leads" and "cut-offs" for both ends of the cylinder, and for backward and forward going, will be practically perfect and equal, and the opening of ports also as near as possible equal. If a longer "cut-off" than 75 per cent. is required, it is only necessary to increase the angle of the curve link $o\ o$ beyond s' for forward gear, or beyond s'' for backward gear. It will be noticed that in this gear the "lap" and "lead" are entirely dependent on the action of the lever $j\ m\ g'$ as a lever, and may be varied according to the length of $m\ g'$. And the opening of the port (beyond the amount given as lead) is dependent on the amount of angle imparted to the curved link $o\ o$, and will be, as above said, about four-fifths of the amount of that angle from the vertical, measured on the line of extreme vibration.

Instead, however, of employing a curved link with slide blocks to guide the centre or fulcrum of the lever 3, this centre may be hung in sling links, having their centres of suspension adjustable in the curve $m'\ m''\ m'''$, such centres of suspension representing the points for "midgear," "backward," and "forward" going. All the rules for laying out the gear will, however, remain the same.

Deviations from the above positions and proportions may be made without materially altering the correctness of the results.

Thus, if it is found necessary to raise or lower the centre m, to clear wheels, frames, or other gear, without altering the position of the valve spindle centre, this may be done till the angle of $m\ m'$ is out of the parallel of the cylinder centre line up or down by one in thirteen; it is not well to go beyond this, but the lines $m\ m'$ and $b\ b$ will be parallel, and the position of the curve $o\ o$, which is the centre line of the curved links, for mid-gear will be at right angles to $m\ m'$.

Again, the point e' may be taken either above or below the centre line of the connecting-rod if it be wished to avoid piercing the rod, the pin at e' being carried in a small bush or block attached above or below the connecting-rod, or to a boss forged on the connecting-rod.

Again, for locomotives, if the wheels are so small that the link $e'\ f$ would come too low, it may be cut short at the point j, and this point connected by a link, $l\ l$, to a small return crank, p, on the crank-pin, the movement of the counter-crank being equal to that from j to j'''.

The diagram is drawn for an engine where the centre of the crank axle is on the centre line of the cylinder, but if this be below, as is usual in American locomotives, then the base line on which to construct the diagram of the valve gear itself will be the average centre line assumed by the connecting-rod for such lowering of the crank axle centre, drawn from c, the middle position, to a point, say r, representing the lowered centre of the axle. The vertical $z\ z$ will be at right angles to this new base line, $c\ r$, all the other processes following.

For vertical engines the same rules apply, by placing the diagram vertically and altering relatively the terms "vertical" and "horizontal."

While the proportions shown on the diagram give the best average results, these proportions may be varied within very wide limits, according to the requirements of the design of the engine. Thus, when the distance between the centre of the cylinder and centre of valve spindle is small, as with a small cylinder and a long stroke, the link $e'\ f$ may be considerably lengthened; the point j will thus be dropped, and convenient angles for all the links, etc., will be maintained, the room for the various movements being got below the centre line of the cylinder, when it cannot be had above.

In marine engines the reverse conditions are usual, the distance between the cylinder and valve spindle centres being abundant, and very little room available behind the engine. In this case the point e' may be taken out of the centre line of the connecting-rod (see fig. 4), so bringing all the gear so much further forward. The end of the link 1 may then be swung at f by the link 2 centred either above, as at f', or below, as at f'', or it may be carried in a cross-slide, f'''.

Also to accommodate the centre lines of the valve spindles of the high and low-pressure cylinders (if different), one centre may be carried outward to b' and the other inward to b'', from the normal centre line b'; this angle may be as much as one in twelve without affecting the accuracy of the gear. The centre line of the quadrant at mid-gear will, however, be always at right angles to the altered vertical centre line. In all cases it is well to keep the levers and links as long and the angles as easy as the room at disposal will allow.

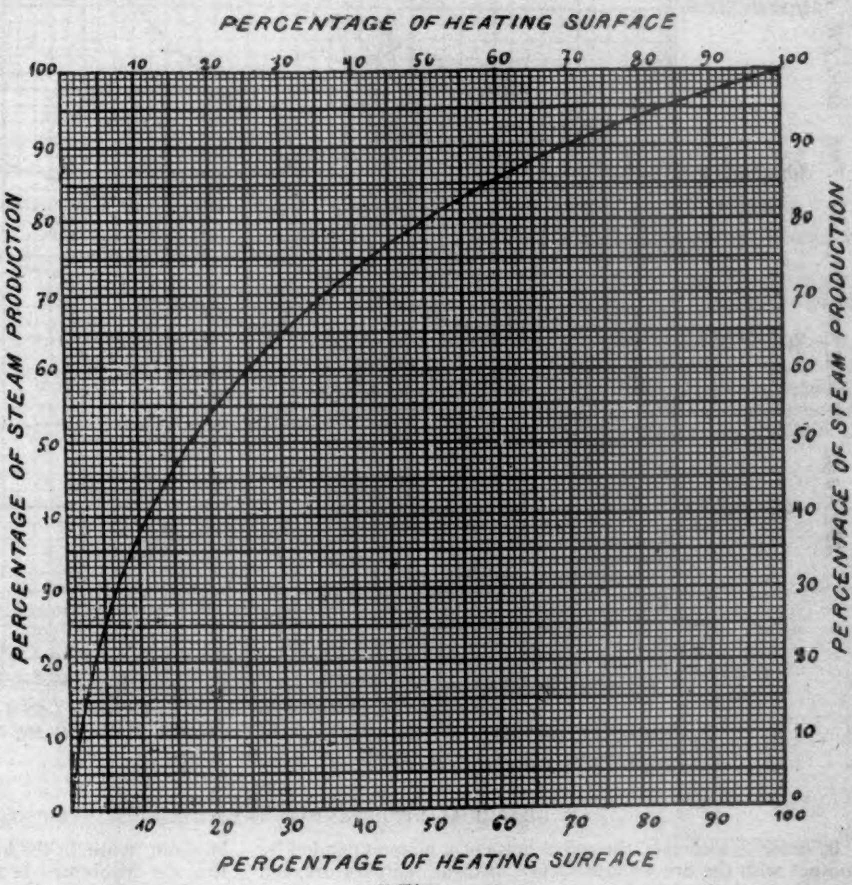


Fig. 1.

STEAM CURVE FOR LOCOMOTIVE BOILERS, ACCORDING TO COUCHÉ.

THE DETERIORATION OF LOCOMOTIVE AND MARINE BOILERS DUE TO EXPANSION, AND THE MEANS OF LESSENING THE SAME.*

By Herr Lentz.

It is well known that when a boiler is heated it expands, and that its dimensions change. These conditions have, up to the present time, not been demonstrated with sufficient clearness

* Paper read before the *Verein für Eisenbahnkunde.*

to enable us to reach a conclusion as to the defects existing in each boiler, and lead us to a more rational method of construction. Also the diminished factor of safety and the low limit of elasticity in the high-pressure boilers receive but little attention. I will, therefore, straightway show you the observations and calculations which I have made regarding these expansions that result from the heating, and then elucidate the conclusions which I have deduced therefrom.

We find in the fire-boxes of locomotives and other boilers certain deformations that are for the most part due to the difference in temperatures of the several parts and the slight elasticity existing between them, and which offer the means for the application of methods for obviating the difficulties that have as yet received but a limited adoption.

Deformations have also been found in the nests of tubes of stationary and marine boilers, as well as in those of locomotives, without the prevailing changes which are the root of the whole evil being thoroughly examined.

which gives the heating surface and steam production in percentages, so that if we know what percentage of the total heating surface is to be found in the fire-box, we can straightway read the percentage of total steam production that is to be attributed to it.

We also see, from this curve, how rapidly the steam production of the tubes falls off at the smoke-box end. For example, in the first 10 per cent. of the heating surface 38 per cent. of the evaporation is accomplished, while in the last 30 per cent. only 10 per cent. is done. Thereby we can calculate how many pounds of water is evaporated per square foot of fire-box heating surface, and how many for that of the tubes.

In order to determine the mean temperature of the sheet from the steam production per square foot of heating surface, we can avail ourselves of the table (fig. 2) of Hirsch, which was first published in the *Annales du Conservatoire des Arts et Metiers*, at Paris in 1889.* In the vertical columns the mean temperature of the sheet in degrees Fahrenheit and Centigrade

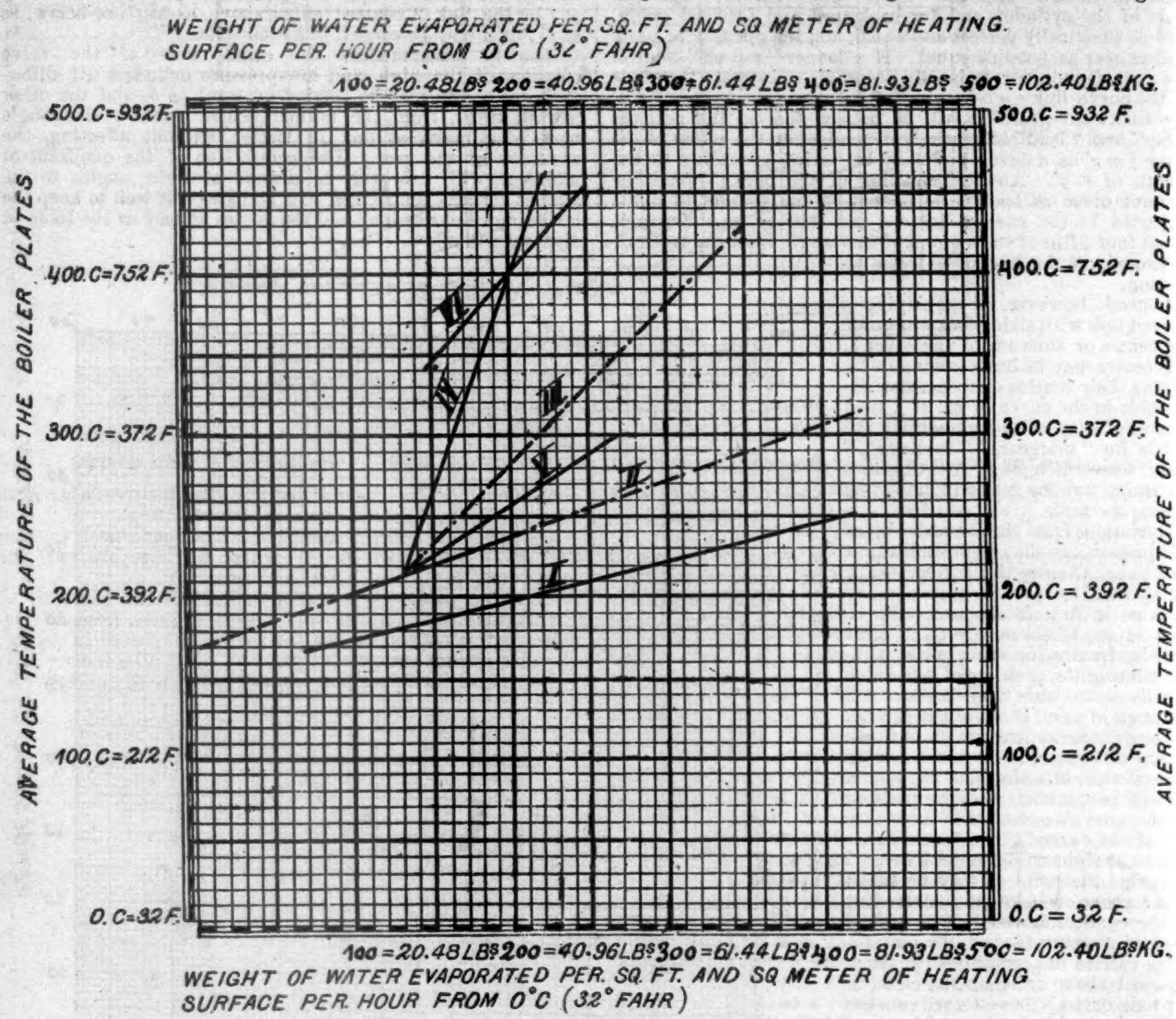


Fig. 2.

GRAPHICAL REPRESENTATION OF HIRSCH'S INVESTIGATIONS.

In order to ascertain the exact mass of a plate expanded by contact with the fire we must know its mean temperature, and in order to determine this we must know the amount of heat that it imparts to the water and how much water it evaporates per square foot of heating surface per hour. In order to get this it is necessary to know the total amount of steam generated in the boiler per hour.

Experiments have frequently been made to determine with great accuracy the evaporative efficiency of locomotive boilers, so that for a given machine it is easy to fix the number of pounds of water that the boiler will evaporate per hour.

It must then be ascertained how much is evaporated by the fire-box and how much by the tubes. In this connection the investigations of Messrs. Geoffroy and Delebecque of the Northern Railway of France, and which were published by Couché in his work, are of the highest value.

From these investigations I have plotted a curve (fig. 1)

is given, while in the horizontal lines are the weights of water that are evaporated in pounds per square foot and kilograms per square metre of heating surface.

Hirsch carried on his experiments in determining the mean temperature of the plates by means of various fusible plugs having different melting-points, and thus plotted the lines that are given. The lowest line, I, is for a clean upper surface of the sheet and distilled water, so that the temperature of the sheet is quite low. Line II is for a sheet that was covered with a scale .04 in. thick, and line IV for one where the scale was .2 in. thick.

Hence it appears to me that if we take .04 in. for the thinnest layer of scale and .2 in. for the thickest, we may safely take .12 in. as the average, and by bisecting the angle between

* The table published in fig. 2 is modified from the one actually published by Hirsch, which read in kilograms, square metres and degrees Centigrade, o read in pounds, square feet and degrees Fahr.—ED.

the lines II and III obtain the line IV, which may be assumed as representing a fair average to be adopted in our calculations.

Line V is for a sheet covered with mineral oil, and line VI for a double sheet with an interposed layer of tallow .004 in. thick.

Although these experiments were made with iron boiler plates, yet when there is a layer of scale .12 in. thick the difference in the evaporative efficiency between iron and copper will be so slight that, in what follows, the line III will be considered as exceeding the average.

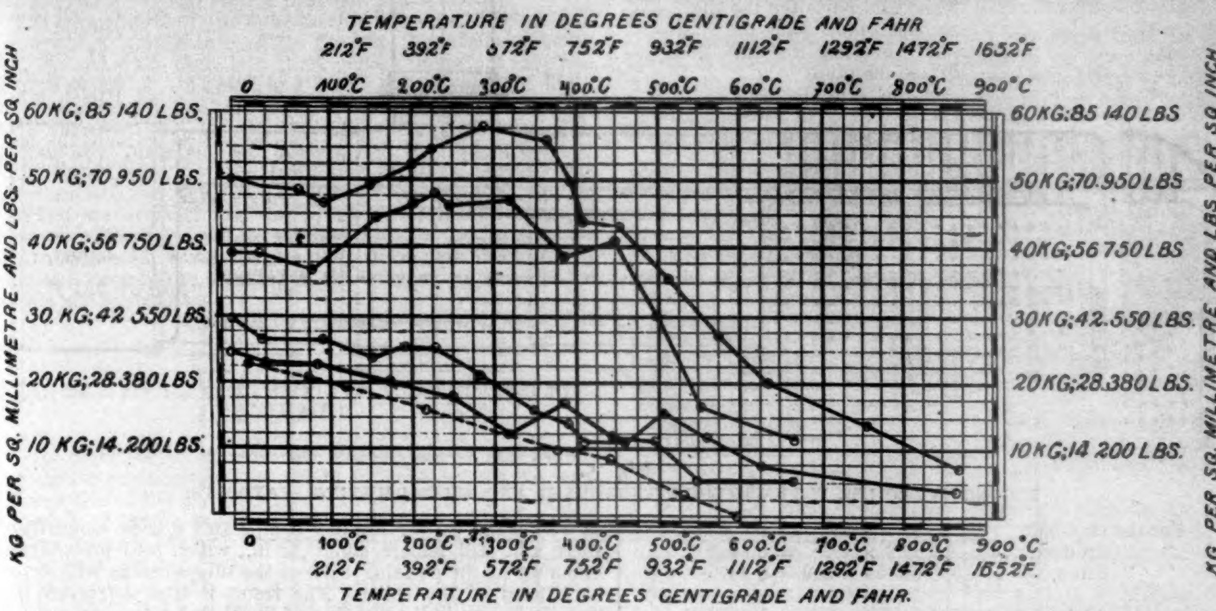


Fig. 3.

DIAGRAM OF THE TENSILE STRENGTH AND LIMIT OF ELASTICITY OF STEEL, WROUGHT IRON, AND COPPER.

Hirsch made his experiments on evaporative efficiency with the valve open, and at 212° F.; to the figures that have been found, therefore, about 180° F. (100° C.) must be added.

For example, suppose there are 45 lbs. of water evaporated at a pressure of 12 atmospheres from each square foot of heating surface per hour, wherein the temperature of the steam is 375° F.; with pure water and a clean plate the temperature of the plate becomes 400 + 160 = 560° F.; with .04 in. of scale, 470 + 160 = 630° F.; with .12 in. of scale, 570 + 160 = 730° F.; and for .2 in. of scale, 840 + 160 = 1,000° F., which would

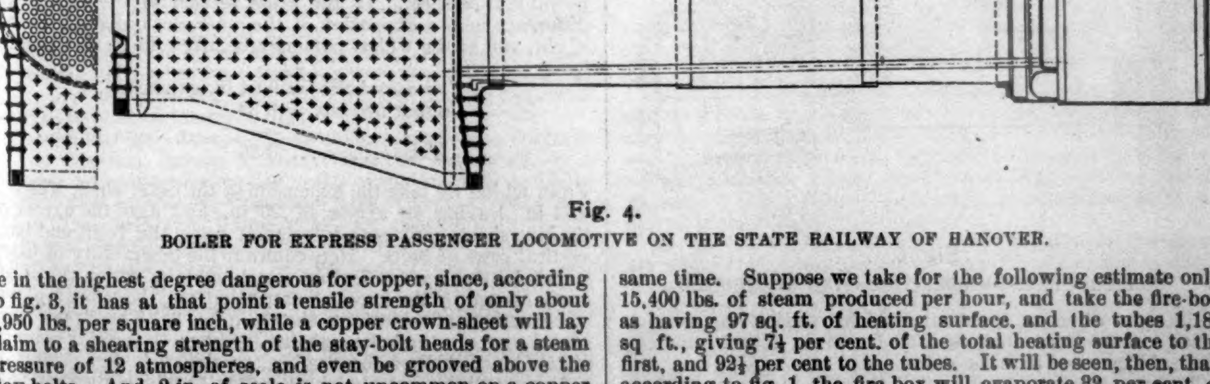


Fig. 4.

BOILER FOR EXPRESS PASSENGER LOCOMOTIVE ON THE STATE RAILWAY OF HANOVER.

be in the highest degree dangerous for copper, since, according to fig. 3, it has at that point a tensile strength of only about 1,950 lbs. per square inch, while a copper crown-sheet will lay claim to a shearing strength of the stay-bolt heads for a steam pressure of 12 atmospheres, and even be grooved above the stay-bolts. And .2 in. of scale is not uncommon on a copper crown-sheet.

From the ascertained temperature we are now to calculate the expansion, which I take to be $\frac{1}{950}$ for wrought iron and $\frac{1}{580}$ for copper for each 180° F. or 100° C., or $\frac{1}{1710}$ and $\frac{1}{1044}$ per 100° F. respectively. If we have now calculated the tension resulting from expansion, fig. 3 will serve to tell us whether the limit of elasticity or tensile strength has been exceeded by the corresponding temperature. The two upper lines represent the tensile strengths of steel and wrought iron; the next two, the limits of elasticity of the same, according to the experiments made by the Navy Department of the United States, and it is interesting to note that while the tensile strength is the highest at about 575° F., the limit of elasticity drops continuously. The lower dotted line gives the tensile strength of copper, which drops to zero at about 1,110° F.

Let us now take for an example our new four-wheels coupled high speed locomotive (fig. 4), where we have observed the expansions lengthwise, across and vertically.

According to the investigations of the Messrs. Lochner * at Erfurt, the boiler, which only differs slightly from the so-called Erfurt boilers, evaporates from 12,000 lbs. to 19,800 lbs. of water per hour at a steam pressure of 12 atmospheres, and when running at a speed of from 31 miles to 56 miles in the same time. Suppose we take for the following estimate only 15,400 lbs. of steam produced per hour, and take the fire-box as having 97 sq. ft. of heating surface, and the tubes 1,184 sq. ft., giving 7½ per cent. of the total heating surface to the first, and 92½ per cent to the tubes. It will be seen, then, that, according to fig. 1, the fire-box will evaporate 32 per cent. of

* *Organ für die Fortschritte des Eisenbahnwesens*, 1894, vol. xxi., Nos. 3 and 4, page 108.

the 15,400 lbs. or 4,928 lbs., and so for a heating surface of 97 sq. ft. the rate of evaporation is 50.8 lbs. per square foot. For the tubes the same calculation gives 8.84 lbs. per square foot of heating surface of the tubes.

According to fig. 2 we find that for the fire-box 630 + 160 = 720° F., and for the tubes 360 + 160 = 520° F. expresses the average temperature of the material, from which we can obtain the expansion of the several parts; hence we have:

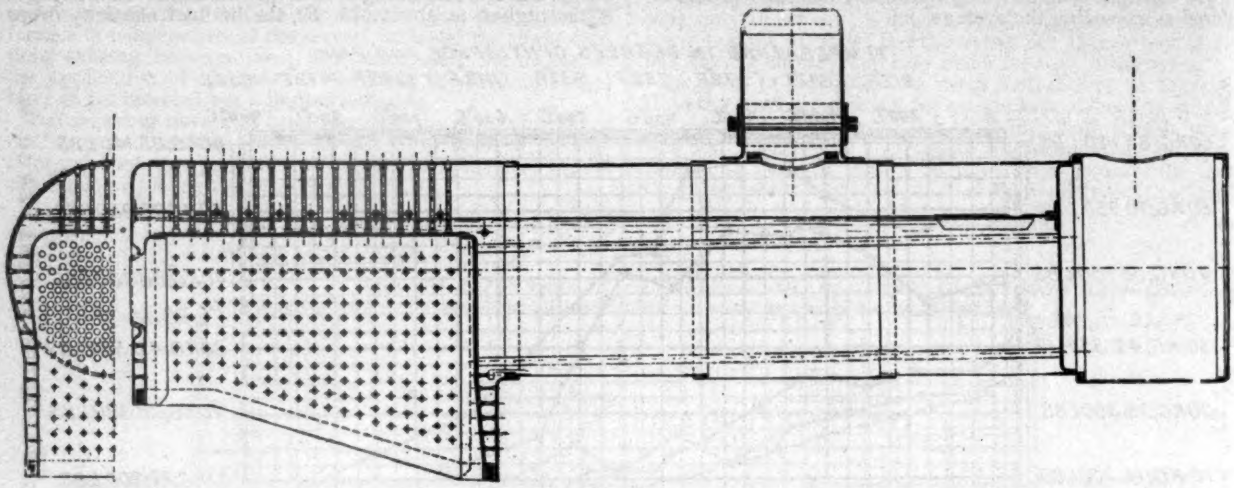


Fig. 5.

LOCOMOTIVE BOILER WITH FLEXIBLE TUBE SHEET AND SELF-ADJUSTING STAYBOLTS.

For the stay-bolts, $\frac{1}{1044} \times 2.67 \times 3.7 = 0.0094$ in.
" " fire-box, $\frac{1}{1044} \times 88.3 \times 7.2 = 0.6089$ "
" " tubes, $\frac{1}{1710} \times 153.55 \times 5.2 = 0.4675$ "

Total.......................... 1.0858 "

The temperature of the outer shell is practically within 5 per cent. of the temperature of the water, which in this case amounts to 351½°, and we calculate the expansion of the outer shell therefrom as

$$\frac{1}{1710} \times 244.52 \times 3.515 = .5025 \text{ in.}$$

The expansion of the inner portion is therefore .5835 in greater than the outer. But the latter will also be stretched

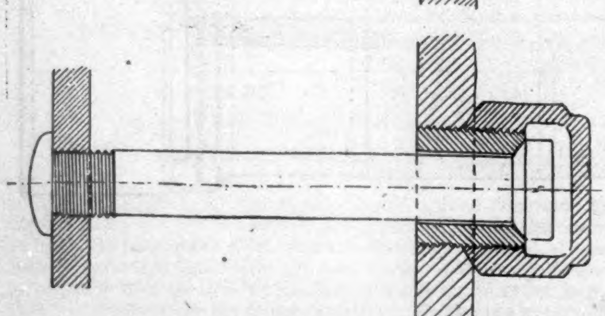


Fig. 6.

CONSTRUCTION OF SELF-ADJUSTING STAYBOLTS.

in the same direction by about .0366 in., so that the total expansion of the inner shell is .5469 in., or, in round numbers, about .55 in. more than the outer.

The extension of the outer shell through the steam pressure acting longitudinally resolves itself into a drawing out of the metal, which for a modulus of elasticity of 12,900,000 becomes in this case

$$\frac{1935 \times 244.52}{12,900,000} = .0366 \text{ in.}$$

The tubes will now press against the tube-sheets in order to make up for this .55 in., and if they are but slightly compressed in their length as well as sprung a little out of line, and the strong tube sheet of the smoke-box sprung a little as well as the copper fire-box compressed a trifle lengthwise, there will still remain about .38 in., which will probably be taken up by the pressing back of the tube-sheet as well as the back head of the boiler. The result is that a fracture frequently occurs in the flanging of the back head.

The tubes are pushed with great force against the tube-sheets as a result of these expansions, and are often shoved through the one at the fire box end; yet when this is made fast with a shoulder it frequently happens that it is pushed through at the smoke-box end. As a general thing the tubes remain tight in the latter, for the temperature is not so high at this point, while at the fire-box end, where the temperature of the tube-sheet is the highest, averaging about 90° F. higher than the average temperature of the fire-box, the copper, which is used for tightening the tubes, will be stretched beyond its limit of elasticity, and will not return to its normal position, so that the expansion of the tube will cause it to yield, the ends will be pushed through, and a considerable play of the tubes is the unavoidable result.

Now, if a flexible tube-sheet is used, as is shown in fig. 5, the steam pressure acts upon this elastic ring and presses out the tube-sheet several millimetres, so that the expansion of the tubes and a portion of that of the fire-box is taken up, so the tubes remain perfectly tight and yet free to expand in the boiler, and there is room for the movement and action of the tubes to take place, while the fire-box tube sheet will no longer be pushed back, the strain on the back sheet of the fire-box will be greatly modified and the stay-bolts will be able to work normally.

When there is a steam-pipe lying inside the boiler, as in the foregoing construction, a stuffing-box must be placed in the movable tube-sheet. In the cross section of the fire-box the difference in the expansion of the inner and outer shell is but slight, and at the widest part may be taken to be about as follows:

Two stay-bolts = 0.04 in. expansion.
Copper fire-box = 0.32 " "

Total......... 0 36 " "

From which we take the expansion of the outer shell, which is 0.11 in., leaving an excess of .25 in., and also the excess on the side sheets only acts injuriously upon the front and back vertical rows of bolts. Here comes in the desirability of using stay-bolts that have a flexible attachment, by which the angularity caused by the unequal expansion may be taken up, two constructions of which are shown in fig. 6. The upper horizontal row of stay-bolts sustains its greatest angular bending at the inner shell of the fire-box, as shown in figs. 4 and 5; it is very slight, but the short radius to which they are bent makes a row of movable stay-bolts very desirable at this point.

The vertical expansion of the fire-box shows a still greater difference. In the foregoing instances it is comparatively

slight on the back end, where the height is only a trifle more than 3 ft. and the temperature is considerably below the average. But they should be used in deep fire-boxes, where the back axle does not come below the grates, as in the English engines. In these boilers the movements have the same unfavorable tendencies as at the tube-sheets, and a good construction of the door opening is necessary, as is shown in the preceding case, where the stiff door rings are avoided; and although there is a cooling of the water, a certain elasticity is obtained and the slight vertical motion provided for.

The temperature of the tube-sheet is somewhat higher than the average temperature of the fire box, the minimum being 840° F., and when there is a thick deposit of scale it may rise as high as 930° F. At 840°, and with a tube-sheet 57 in. high, the expansion will be $\frac{7}{16}$ in. and $\frac{1}{2}$ in. for the outer shell, leaving a variation of $\frac{5}{16}$ in. In order that this movement of $\frac{5}{16}$ in. may take place and the fire-box rise, the copper must be bent upward ahead of the front row of stays, provided the latter are stiff and rigid.

When we consider the similar and coincident horizontal pressure of the tubes and the vertical thrust of the braces upon the tube-sheet, it is astonishing that the copper sheet lasts as long as it does before breaking at the flanging when subjected to this maltreatment.

(TO BE CONTINUED.)

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in January, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN JANUARY.

Galion, O., January 1.—There was a collision at Yorktown, on the Big Four Railroad, this morning between two freight trains, in which W. A. Shull, an engineer, and Joshua Walsh, a fireman, were killed, and Charles Sutton, an engineer, and Henry Hurst, a fireman, were badly injured.

Fort Worth, Tex., January 1.—Silas S. Melson, a fireman on the Texas & Pacific Railroad, was badly hurt by falling under his engine at Forney this evening. His left hand and left foot were injured, and he is supposed to be internally injured.

Philadelphia, Pa., January 1.—A collision occurred at Wingohocking, on the Philadelphia & Reading Railroad, this evening between two passenger trains, in which Engineer Snyder was injured. The collision was caused by a misplaced switch.

Bainbridge, O., January 2.—Owing to a misunderstanding of orders, a collision occurred between two freight trains on the Ohio Southern Railroad to day. Fireman Charles Snyder was instantly killed, his neck being broken; Engineer William Hayes had his leg broken; Engineer Burt Simmons was badly hurt about the head and legs, and Fireman Charles Crawford was badly hurt on the right side.

Greenville, Tex., January 5.—William Greenlee, an engineer on the Missouri, Kansas & Texas Railroad, was struck by a switching engine here to-day. His right leg was so badly crushed that he will die from the effects of his injuries.

San Francisco, Cal., January 5.—An express train on the Southern Pacific Railroad collided with a work train in the Altamont Tunnel to-day. The fireman of the express was killed outright, and the engineer was so fearfully mangled that he died from his injuries. Both trains had been informed that they had the right of way.

Wellsboro, Pa., January 5.—A fast freight train on the Fall Brook Railroad jumped the track near Middleburg this morning, and Engineer McQuade was pinned beneath the wreck. It was 20 minutes before he could be released, when it was found that his legs, back and right arm had been literally cooked by the escaping steam, and that his body was frozen, the thermometer being 20° below zero. He was alive when released, but died from his injuries.

Cleveland, O., January 7.—A head-end collision occurred on the Wheeling & Lake Erie Railroad near Smithville to-day. Fireman J. W. Walker was caught in his cab and roasted to death. Engineers Burkhart and Burns were badly though not fatally hurt. One of the firemen is missing.

Falls City, Neb., January 8.—William Rowley, an engineer on the Chicago, Burlington & Quincy Railroad, was run over this afternoon, and had both legs cut off. He died shortly afterward.

Chattanooga, Tenn., January 8.—A passenger train on the Queen & Crescent Route was wrecked by an open switch at Attalla to-night. Fireman Roy Johnson was killed by falling under the engine, and the engineer had his arm badly bruised and broken.

Brooklyn, N. Y., January 10.—An engine on the Kings County Elevated Railroad got beyond the control of the engineer this evening, and crashed through the bumper at the end of the rails. The engine went to the street, and pinned the fireman beneath it. He was rescued after some time, but was so badly injured that he died. The engineer jumped just before the engine struck the ground and escaped with a broken leg and a fractured frontal bone. He is expected to recover.

Pittsburgh, Pa., January 11.—A rear-end collision occurred on the Pennsylvania Railroad at Versailles this evening. The engineer and fireman jumped, the former sustaining a bad sprain of the knee. The accident was caused by the breaking in two of the leading train.

Kansas City, Mo., January 11.—A switch engine in the Hannibal & St. Joseph yards collided with a Wabash passenger train to-day. Engineer C. W. Olman was killed and Fireman J. R. Nettles fatally injured.

Logansport, Ind., January 12.—A freight train on the Pan Handle Line was thrown from the track here to-day by a switch becoming filled with and packed with snow and ice. Fireman S. G. Lucas was badly hurt.

Milwaukee, Wis., January 12.—There was a collision between a light engine and a freight train on the Chicago, Milwaukee & St. Paul Railroad at North Avenue Station this morning. Engineer Zolowiez, of the switch engine, had his arm and leg broken.

Indianapolis, Ind., January 13.—A passenger and freight train on the Indiana, Decatur & Western Railroad collided 45 miles west of here this morning. William Fletcher, engineer of the passenger train, was killed.

Las Vegas, N. M., January 14.—A freight train on the Atchison, Topeka & Santa Fé Railroad ran into an open switch east of here this morning. Fireman Dodson and Engineer Collins were fatally injured, the latter being scalded.

Kansas City, Mo., January 15.—Engineer Myers, of the Atchison, Topeka & Santa Fé Railroad, fell into a cinder pit this afternoon and was severely hurt about the side.

Boston, Mass., January 15.—An engine and three cars of a freight train on the New York & New England Railroad plunged into an open drawbridge at South Boston to-night. The fireman escaped by jumping, but the engineer was carried down with the engine and buried beneath the wreck.

Reno, Nev., January 17.—A passenger train on the Southern Pacific Railroad ran into an open switch at Wadsworth this morning, and was wrecked. The engineer was seriously hurt, as was the fireman also.

Massillon, O., January 17.—A head end collision took place on the Wheeling & Lake Erie Railroad to-day. Fireman Ryan was badly injured.

Bloomington, Ill., January 21.—Philip Neuhaus, a fireman on the Illinois Central Railroad, fell from his engine this morning and sustained a concussion of the brain, from which he died in a short time.

Bradford, Pa., January 22.—Three sections of a freight train on the Buffalo, Rochester & Pittsburgh Railroad were running close to each other near here to-day, when the second section was obliged to slow up. The flagman did not have time to signal the third section before it crashed into the second. Fireman William Baxter had his arm so badly crushed that it had to be amputated.

Mt. Airy, Ga., January 24.—A freight train on the Southern Railway ran into a landslide near this place this morning. Fireman Harry Wooten was injured, but not seriously.

Columbus, S. C., January 25.—Train wreckers wrecked a passenger train on the Southern Railroad near Moorhead, Miss., this morning. Engineer Graham Jones and Fireman Harvey Woods were caught under the engine and terribly scalded.

Bridgeport, Conn., January 26.—G. Frank Northrop, a fireman on the Consolidated Railroad, was struck on the head by the Park Avenue Bridge this afternoon and killed.

LOCOMOTIVE RETURNS FOR THE MONTH OF NOVEMBER, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Locomotive Mileage. Freight Trains.	Locomotive Mileage. Service and Switching.	Locomotive Mileage. Total.	Locomotive Mileage. Average per Engine.	Av. Train. Passenger Cars.	Av. Train. Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Coal Burned per Mile. Freight Train Mile.	Coal Burned per Mile. Service and Switching Mile.	Coal Burned per Mile. Train Mile, all Service.	Coal Burned per Mile. Passenger Car Mile.	Coal Burned per Mile. Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Cost per Locomotive Mile. Fuel.	Cost per Locomotive Mile. Oil, Tallow and Waste.	Cost per Locomotive Mile. Other Accounts.	Cost per Locomotive Mile. Engineers and Firemen.	Cost per Locomotive Mile. Wiping, etc.	Cost per Locomotive Mile. Total.	Cost per Car Mile. Passenger.	Cost per Car Mile. Freight.	Cost of Coal per Ton.
										Lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	864	789			292,240	2,064,242	2,701						84.21			3.80	7.15	0.26	0 20	6.79	1.21	19.41			1.62
Canadian Pacific	609		466,783	796,824	259,579	1,525,066	2,504						76.22			3.85	11.00	0.19		5.75	1.27	22.06	1.86		2.02
Chicago, Burlington & Quincy																									
Chicago, Milwaukee & St. Paul																									
Chicago, Rock Island & Pacific			457,076	817,641	353,524	1,628,241		5.40	18.20	59.06	79.27	45.52	68.00	11.00	4.77	2.77	6.59	0.20		6.04	0.52	16.12			2.06
Chicago & Northwestern	1010		774,215	1,383,904	613,858	2,771,977							94.34			3.18	8.20	0.27		6.27	0.82	18.74			1.73
Cincinnati Southern																									
Cumberland & Penn.*		23	5,617	37,320		42,937	1,866						86.39			6.78	4.67	0.32			1.61	13.38			
Delaware, Lackawanna & W. Main L.	213	195	70,070	598,656		668,726	3,429						85.10			3.17	6.21	0.38		5.77		15.53			1.46
Morris & Essex Division	162		179,891	228,671	11,087	419,649							69.51			3.57	10.83	0.34		7.10		21.84			3.09
Flint & Père Marquette			84,235	77,852	45,311	207,398	2,469			52.21	100.19	41.18	70.06			3.18	6.49	0.11	0.04	5.01	0.99	15.82			1.77
Hannibal & St. Joseph			64,933	132,009	34,236	231,026	3,500	5.13	17.60				87.22	13.71	6.43	2.31	6.86	0.18	0.42	6.99		16.71			1.57
Kansas City, Ft. S. & Memphis	140		93,179	187,887	88,782	369,848	3,056						72.20			2.73	5.15	0.25	0.41	7.34		15.93			1.40
Kan. City, Mem. & Birm	42	37	34,865	55,756	10,925	101,546	2,744						68.94			3.43	3.24	0.19	0.27	6.68		13.81			0.93
Kan. City, St. Jo. & Council Bluffs	38	36	49,829	33,327	38,007	121,163	3,275	5.13	19.81				73.83	15.12	4.83	3.78	6.22	0.14	0.64	6.81		17.61			1.59
Lake Shore & Mich. Southern	590		368,739	861,989	438,523	1,668,251	2,947			67.20	91.74	47.22	73.55			2.78	5.44	0.10	0.07	6.94	0.11	15.44			1.47
Louisville & Nashville																									
Manhattan Elevated		298	734,223		65,195	799,418							43.78			2.50	8.50	0.20	0.50	9.40		21.10			4.01
Mexican Central	148	130				396,606							60.24			4.58	11.67	0.43	0.11	4.96		21.75			3.77
Minn., St. Paul & Sault Ste. Marie															4.59										
Missouri Pacific	351					889,823	3,047	4.39	17.94				89.16	15.91	6.20	4.60	6.21	0.32	1.43	6.55	1.41	20.52	3.84	1.42	
Mobile & Ohio	105	86	75,221	165,816	52,878	293,915	3,415		27.20				71.25			3.00	4.52	0.20	0.56	5.82	0.90	15.00			1.28
N. O. and Northeastern																									
N. Y., Lake Erie & Western	623	373	421,594	774,221	243,153	1,438,968	3,175	4.40	24.60	88.40	145.20	89.50	107.70	20.10	5.90	4.79	7.96	0.32	1.95	7.34	1.25	23.66		1.63	1.36
N. Y., N. H. & H., Old Colony Div																									
N. Y., Pennsylvania & Ohio	289	156	121,911	402,360	146,025	670,296	3,361	5.40	18.90	90.20	133.30	95.90	106.46	16.70	7.00	4.17	6.86	0.29	2.25	7.03	1.06	21.56		1.76	1.17
Norfolk & Western, Gen. East. Div.†			92,445	304,836	53,512	450,793	2,716	5.10	21.30	47.45	107.81		77.63	9.30	6.08	5.69	3.88	0.26				9.83			3.50
General Western Division†			103,373	364,518	63,453	531,344	2,711	5.09	17.29	77.00	135.00	108.00	126.00	15.15	8.30	6.39	4.44	0.23				11.06			
Ohio and Mississippi																									
Philadelphia & Reading																									
Southern Pacific, Pacific System	721	646	617,045	859,042	268,923	1,745,010	2,701	5.36	14.36				69.59			5.51	16.88	0.18	2.27	7.30	1.13	33.27			4.88
Union Pacific	704		396,358	876,003	269,502	1,541,863	3,497	6.26	20.45				116.08	15.26	7.69	7.10	9.50	0.40		9.64	1.00	25.64	3.92	1.65	1.63
Wabash	416	339	419,959	600,267	218,314	1,238,540	3,653	4.70	17.19	75.36	119.04	63.73	94.47	15.96	6.89	3.53	5.65	0.27		5.60	0.82	15.87	2.89	1.05	1.19
Wisconsin Central	149	110	134,814	169,992	75,178	379,984							87.95			2.71	7.20	0.15		6.42	0.78	17.26			1.63

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs, and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

Asheville, N. C., January 26.—A freight train on the Southern Railway ran into a rock slide near Salisbury this morning. Fireman W. L. Simmerson was killed.

Sutton, W. Va., January 26.—Engineer Lloyd Ohldester, employed on the West Virginia & Pittsburgh Railroad, fell beneath his engine to-day and was mangled and killed.

Winsted, Conn., January 28.—A freight train on the New York & New England Railroad left the rails at a point 2 miles west of here this afternoon. The engineer and fireman were injured. The wreck was caused by a brake shoe dropping from the car immediately behind the locomotive.

Syracuse, N. Y., January 31.—Henry R. Woolridge, a fireman on the Delaware, Lackawanna & Western Railroad, was badly injured this afternoon by falling from his engine while at work thereon.

Knox, Ind., January 31.—An engineer on the Indiana, Illinois & Iowa Railroad was severely injured in a rear-end collision that occurred at North Judson this afternoon.

Our report for January, it will be seen, includes 31 accidents, in which 10 engineers and 12 firemen were killed, and 15 engineers and 11 firemen were injured. The causes of the accidents may be classified as follows:

Collisions	11
Derailments	4
Falling from engine	4
Falling into cinder-pit	1
Landslides	2
Misplaced switches	4
Open draw-bridge	1
Run over	2
Struck by obstruction	1
Train wreckers	1
Total	31

General Notes.

The Foster Engineering Company, Newark, N. J., have just entered an order for two mammoth valves, 18 in. and 14 in. in size, intended for the Anheuser-Busch Brewing Association of St. Louis. These pressure regulators are of the Foster new "Class W" style, and when completed will be the largest reducing valves ever turned out of their works. Few if any pressure regulators of equal size are in service to-day.

The Abendroth & Root Manufacturing Company, 28 Cliff Street, New York City, sole makers of the Root improved water-tube boiler and Root's spiral riveted pipe, find business good, and state that the outlook for the ensuing year is "A No. 1." There has been a lively demand for their boilers from the South and West for service in electric lighting and street railway plants. This is a line of work for which the Root boiler is especially well adapted, and for which it has become deservedly popular.

Improvement in Battery Zincs.—The Brady Metal Company, 115 Boreel Building, New York, have been manufacturing for several years an improved crow-foot zinc for battery purposes. They claim that it is a well-settled conclusion among electricians that if you reduce the internal resistance of the battery by bringing the zinc and copper near together it almost doubles the consumption of both zinc and vitriol. With this object in view, a short hanger pattern of the crow-foot battery zinc has been perfected, which they regard as a most decided improvement. The component parts of this zinc are an alloy of zinc and mercury, and it is further claimed that a number of practical tests recently concluded show the superiority of this kind of zinc.

The Brown Hoisting & Conveying Machine Company announce that they have purchased and added to their crane department the entire crane business of the Yale & Towne Manufacturing Company, of Stamford, Conn. The transfer occurred on December 1, 1894, and includes the manufacturing of all the travelling, locomotive, jib, pillar and other cranes, trolleys, tram-rails, etc., heretofore conducted by the Yale & Towne Manufacturing Company. This addition to their present extensive line of cranes and well-known hoisting and conveying machinery enables them to meet all the requirements and wants of customers in the line of electric, steam and hand-power cranes, as well as hoisting and conveying machinery, more completely than any other establishment in the United States. They are pleased to further announce that Mr. F. G. Tallman, 409 Times Building, Pittsburgh, Pa., who formerly represented the Yale & Towne Manufacturing Company in the crane business, will now represent this company, and give his personal attention to the sale of all the various machinery manufactured by them.

PERSONALS.

Clemens Herschel, Member Am. Soc. C. E., delivered a lecture, January 25, on The Measurement of Water before the students of the Rennselaer Polytechnic Institute at Troy, N. Y.

Robert Laidlaw, President of the Laidlaw-Dunn-Gordon Pump Company, of Cincinnati, was elected Treasurer of the National Association of Manufacturers, which convened at Cincinnati the third week in January. Mr. Laidlaw was one of the leading spirits in organization of the Association, and much of the success of the convention was due to his superior executive skill and untiring energy.

OBITUARIES.

Eugene L. Maxwell.

Eugene Lafelle Maxwell, of the firm of Manning, Maxwell & Moore, of New York, President of the Pond Machine Tool Company, of the Ashcroft Manufacturing Company, and of the Shaw Electric Crane Company, died at his home in Brooklyn, on Saturday, February 9th. Mr. Maxwell was born in Brooklyn, and was 44 years old. The business of the well-known firm of which he was a member brought him in relations with a wide circle of acquaintances in various branches of mechanical engineering, among whom he was very popular and had achieved the enviable reputation of being a thoroughly honorable and a very courteous gentleman, a true friend, and a man of very excellent administrative ability.

Edward J. Parkinson.

Mr. Parkinson, who was Chief Clerk in the Machinery Department of the Grand Trunk Railway, at Birmingham, Mich., died of erysipelas after a short illness on February 8 at that place. He was well known among railroad men in the western part of the country. He was born in November, 1844, near Belfast, Ireland, and came to this country when 16 years of age. He entered into the service of the Grand Trunk Railway as a boy in the Mechanical Department at Toronto, and remained in that employ until the time of his death. This was for a period of about 34 years. For the last 27 years he was Chief Clerk in the office over which Mr. Herbert Roberts, the Mechanical Superintendent, now presides. He was of a genial, kindly disposition, and was a good friend to a great many railroad men, who will be greatly grieved to learn of his death.

Loren Packard.*

After an illness of seven weeks Loren Packard, Master Car-Builder at the West Albany Shops, died on the afternoon of February 15 from liver trouble complicated with other diseases.

Mr. Packard was 52 years of age, and was born at Northumberland, N. H. He received his early education in the schools of Waterford and St. Johnsbury. While he was attending school the Civil War broke out, and he was one of the first to go to the front to defend the Union. He enlisted in the First Vermont Cavalry, serving four years. He was in the battle of Gettysburg, and was an eye-witness of the assassination of President Abraham Lincoln, in Ford's Theatre, in Washington, on the night of April 14, 1865.

After serving four years he went to Springfield, Mass., where he entered the Wasson Car Works, and learned the car-building trade. He soon became foreman of the shops, but resigned to accept the position of Master Car-Builder of the shops of the New York, New Haven & Hartford Railroad. He remained in these shops about five years. In 1881 he was offered the position of Master Car-Builder of the Mount Clair Shops of the Baltimore & Ohio Railroad, at Baltimore. He accepted the offer, and remained there about three years. On March 1, 1884, he was appointed to the responsible position of Master Car-Builder of the New York Central & Hudson River Railroad, in charge of the West Albany Shops to succeed the late Mr. Hoit.

* For some of the particulars relating to Mr. Packard's life, we are indebted to the *Albany Evening Journal*.

Mr. Packard was an excellent mechanic, and was truly a *master* car builder. He was a member of the Master Car-Builders' Association, and was for a number of years one of its executive members. He was possessed of an unusual amount of energy, and although his demeanor was ordinarily almost feminine in its gentleness, when emergencies required he manifested an amount of vigor and force of character which would overcome the greatest difficulties, and served to carry whatever he undertook to a successful issue.

He leaves a wife and one son 12 years of age. He was always active in church affairs, and was a member of the First Presbyterian Church of Albany, and for two years past acted as the Superintendent of its Sunday-school, and at the time of his death was President of the Young Men's Christian Association at West Albany. He will be sadly missed in all these relations, and excepting those who were endeared to him by family ties, his loss will be felt most by his old friends and associates. His frankness, generosity, and the kindliness of his character attracted to him many friends who will sincerely mourn their loss.

The funeral services were held on Monday afternoon, February 18, at the church of which he was a member.

Charles W. Copeland.

CHARLES W. COPELAND, one of the best-known marine and mechanical engineers in this country, died in Brooklyn February 5 at his home on Columbia Heights, where he had lived since 1845. Mr. Copeland was born in Coventry, Conn., Conn., in 1815. His father, Daniel Copeland, was a builder of steam engines and boilers in Hartford, Conn., and established the beginning of the plant on the premises afterward occupied by the extensive concern of the Woodruff & Beach Iron Works of that city. Charles W. Copeland, under the direction of his father, was carefully trained in the profession of designing and drafting of steam vessels and machinery, and subsequently received practical instruction in pattern-making, founding, machine-fitting, boiler manufacture, and all the technique of the business then known, and later on became the Superintendent of his father's concern. In this place he designed and built a number of marine steamers for use on the Connecticut and on Southern rivers. About this time he placed himself under the guidance of Professor Hackley, of Columbia College, for instruction in the higher mathematics, of which later on he became an adept.

In 1836 he accepted the place of Designing and Constructing Engineer of the West Point Foundry, of New York, at that time the foremost plant of its kind in this country. While there he designed and built many marine engines, notably those for the United States naval steamer *Fulton*, the steam boats *Utica, Rochester, Swallow, Milwaukee, Cleveland*, and the ferryboats *Gold Hunter* and *Jamaica*, as also the *Bunker Hill* and *Lexington*, some of which were considered marvels of success in their day. He also built the first iron hull in the United States, a boat which plied on Lake Pontchartrain.

In 1839 he was appointed Constructing Engineer to the United States Navy—an office similar to that now occupied by the Chief of the Bureau of Steam Engineering. During the Mexican War he fitted out for the Government what was called the Mosquito fleet, consisting of such steamers as the *Spitfire, Scorpion, Scourge, Vixen*, etc. Later on he designed the engines and boilers of the United States naval steamers *Missouri* and *Mississippi*, and still later the engines and boilers for the naval steamer *Michigan*, for Lake Erie, which was the first iron steamer ever used for naval service. At a subsequent date he designed the machinery for the United States steamers *Saranac* and *Susquehanna*, in which he introduced many novel features of marine engineering. After this he became Superintending Engineer of the Allaire Works, of New York, where he designed and built the machinery for the Collins steamers *Pacific* and *Baltic*; also the *Panama* for the California business; the *Bay State* and *Empire State* and *Traveller* for the Long Island Sound, and the *Harriet Lane* for the United States Revenue Service. When the United States Steamboat Bill of 1852 was before Congress, Mr. Copeland was called upon for his opinion on many subjects, more or less new, then contemplated in the proposed law, and subsequently he was appointed the first supervising inspector under the new law for the New York district, which place he retained for about nine years.

During the War of the Rebellion Mr. Copeland was largely engaged in altering and fitting steamers for the fleets engaged on shallow waters of the Southern rivers, and it was through his advice that many double-enders were brought into use for the intricate channels of those rivers.

Since then he had been Consulting and Superintending Engineer to the United States Lighthouse Board, generally designing and superintending the building of vessels for that service. He was a director of as well as Consulting Engineer to the Norwich & New York Transportation Company, and while in that service designed the steamers *City of New York*, *City of Boston*, and latterly the *City of Worcester*.

All through his life he was a close student, and was a subscriber to most of the magazines and publications pertaining to his profession, both here and abroad, and was often himself a most interesting contributor, and in his earlier career delivered a course of lectures on the steam engine.

The deceased was a widower, and leaves one son, Charles E. Copeland, and four daughters.

We are indebted to the New York *Tribune* for most of the above account of Mr. Copeland's life.

PROCEEDINGS OF SOCIETIES.

The Engineers' Club of Philadelphia.—At a recent meeting Mr. V. Angerer read a paper on Investigation and Experiments for the Determination of the Groove in Guard Rails for Street Railways. The method of making the experiments was to take two pairs of wheels, carefully turned out of hard wood to accurate scale of 3 in. to 1 ft., and with their axles, on which they were turned, secured to a strong frame representing the truck, so that they could revolve freely, but without any play whatever. The frame was rigidly fastened in the centre to a stiff board extending at right angles with the truck to what would be the centre of the curve. A pin accurately turned and fitting snugly in holes in the board and holes in a wooden stand screwed to the floor formed the centre proper. A large piece of drawing paper was stretched on a board, and on it were laid rail blanks without any groove, formed out of potter's clay, following the curves described by the wheels when allowed to move, guided by the board from the centre of the curve to whatever radius it was set. The wheels were then set upon the rail blanks and weighted until their flanges sank into the clay to their full depth, at which point the whole apparatus was arranged to be exactly level. The wheels having previously been varnished. were thoroughly oiled, so that the clay would not stick to them. The first pair of wheels was then revolved from the axle by hand, and thus the truck moved along the potter's clay, the flanges cutting their own grooves into it. The length of arc available having been traversed, the truck was lifted away, and if a perfect impression had been obtained, short pieces were cut out of various parts of the arcs of both the inner and outer rail, and particularly of those parts which had been traversed by the front wheels only or the hind wheels only, and those that had been passed over by both wheels, as comparison of them would show whether or not the truck stood exactly square with the radial line, and on account of some peculiarities yet to be mentioned These pieces were cut out so that the cut would also sever the paper underneath, and extending a short distance inside and outside, forming a strip on and by which the cut-out pieces could be slid away upon another board and put away to dry and harden without handling the piece itself while yet soft, thereby avoiding possible distortion, except on the very ends by the cutting knife. As this latter was unavoidable, the pieces, after being thoroughly hardened, were sawed in half, so as to get at the central undistorted section, and the sawed surface ground smooth on a piece of slate, so as to present sharp lines. The shrinkage of the clay in drying could well be neglected, as actual measurement on a test piece showed that it would amount to a little more than $\frac{1}{64}$ in. in the full size width of the groove.

The wheel used had the Whitney standard flange for electric cars, and representative sections were obtained and enlarged to full size for the different sizes of wheels in common use, the four ordinary lengths of wheel base and radii of curvature for the rail differing by 5 ft. from 30 ft. to 65 ft.

The gauge of the track and the wheels was also considered, and it was found that for the usual gauges, flanges and wheel bases the track gauge is from $\frac{3}{8}$ in. to $\frac{1}{4}$ in. greater than the wheel gauge between the limits of 30 ft. and 60 ft. radii. A clearance of $\frac{1}{4}$ in. seems quite sufficient for street railways, and in fact will make cars run smoother on straight track on account of not allowing so much side sway. Diagrams of the results obtained were exhibited by the author.

The Southern & Southwestern Railway Club will hold its next meeting at the Kimball House, Atlanta, Ga., on Thursday, April 18, 1895, at ten o'clock A.M. The subjects for discussion will be: 1. Revision of Master Car-Builders' Rules of Interchange; and any member having any suggestions to make or changes to recommend will please transmit the same to Mr. R. D. Wade, S.M.P., Southern Railway Com-

pany, Washington, D. C., Chairman of Committee on M. C. B. rules. 2. What is the Cause of Uneven Wear of Driving-wheel Tires Running in the Southwestern Territory? 3. What is the most Economical Method of Obtaining Compressed Air for General Use in Railroad Shops, and its Application? 4. Discussion of the Report on Counter-balancing of Driving-wheels. 5. Additional Report of Committee on Draft Sheets, and Discussion of the Subject. 6. What is the most Economical Tonnage Spring: the Elliptic, Half Elliptic, or the Coil, Considering the First Cost and the Duration of Efficiency of Each, and its Effect on the Rolling Stock and Track?

American Society of Mechanical Engineers.—Arrangements have been made for holding the monthly meetings of mechanical engineers that were so successfully inaugurated during the last season. They will be for the discussion of mechanical subjects, and will be held at the rooms of the Society, at 12 West Thirty-first Street, New York City. The proceeding of each month will consist of an address on some topic of current engineering interest, delivered by an engineer at the invitation of the committee, followed by a discussion of the subject by those in attendance. Persons interested in the subject of discussion are invited to send objects, such as test specimens, photographs, drawings, etc., which may be of interest in connection with the topics to be considered. Members who are unable to attend the meetings are invited to send written discussions on the subject for the evening. The first meeting was held on Wednesday evening, January 23, when Mr. A. Fteley, Chief Engineer of the Aqueduct Commission, presented a paper on the Growth of the Water Supply of New York from Early Days to the Present Time. The meeting was presided over by Mr. Charles H. Loring, Chief Engineer of the United States Navy. The second meeting was held on the evening of Wednesday, February 13, when the subject of the application of electric motors to the driving of machinery was presented and discussed. A report of the meeting will be found in another column of this issue. The dates for future meetings will be Wednesday, March 13, Wednesday, April 10, and Wednesday, May 8.

American Railway Master Mechanics' Association.—The following circular has been issued by the committee on the Utilization of Railroad Scrap Material: "Your committee to report on Utilization of Railroad Scrap Material and the Best Method of Handling the Same, desires information upon the subject from every member of the Association. This may take the form of a general statement covering the treatment of the scrap pile as a whole, or a detailed account of your method of utilizing some part of the material usually found therein, or preferably both. Figures showing the saving in cost, or the reverse, resulting from the working over of scrap, as compared with the cost of new material with the scrap, value of the old material deducted, will be especially desirable. The following questions are given merely by way of suggestion, and it is not expected or desired that members will confine their replies to answers thereto: 1. What is your method of sorting scrap material? 2. Do you arrange with reference to possible future use, or only with reference to kind of material? 3. What classes of scrap can be conveniently used without passing through the foundry, the rolling mill or the forge? 4. What are some of the instances in which the working over of scrap may be expected to show an economy over the cost of new material, and can you give in detail methods found best in your own experience? 5. Can you suggest any way in which economical use may be made of scrap bolts, nuts, links and pins, springs, truss rods, tires and other of the smaller parts of rolling stock which accumulate most rapidly in the scrap pile? 6. What use do you make of scrap axles? Though this subject has been but little discussed, it is one which has an important bearing upon railroad economy, and is therefore one in which every member has an interest. This, added to the practical knowledge which each member must have with some phase of the subject, should insure such a number of full replies as to enable your committee to submit a complete report. Answers should be mailed to H. P. Robinson, Monadnock Block, Chicago, Ill., at the earliest possible date.

Master Car-Builders' Association.—The following circular has been issued by the committee having in charge the revision of the rule of interchange:

"In presenting this circular your committee trusts that it will not be considered as undertaking the question in hand in any radical way. There has been a tendency for the past few years in the deliberations at the Master Car-Builders' conventions, and in the actions of these conventions, to put upon car owners, in the rules of interchange, more and more responsibility for defects in freight cars, and it is now the intention of the committee to see whether the matter cannot be put in such shape as will decrease not only the cost of repairs to the railroads of the country, but will also eliminate the serious detentions to cars which occur at all interchange points.

"The idea is to have cars pass from one road to another if in safe condition for movement, and that the inspection, in so far as stopping cars at junction points is concerned, shall be made simply for safety.

"It should be considered that the railroads, when moving foreign cars, are paying to their owners for their use a sum, in a general way, adequate to cover all natural wear and tear and replacement of equipment destroyed and worn out; so that, in a general way, the owners of cars are paid for the cost of repairs necessary by foreign mileage of their cars.

"It is probably time that the selfish view, as acted upon at interchange points, in endeavoring to make the connecting lines stand all expense possible in repairs of cars which may be offered for movement, should be considered as no longer serving the individual interest of railroad companies.

"It is desired to have a full expression of your opinion, especially in connection with the questions following, sending same to the Chairman, Pulaski Leeds, care of Louisville & Nashville Railroad Company, Louisville, Ky.; and we trust that you will look upon the matter in as broad a view as possible, considering always that the general interest of the railroads at large must be the interest of individual railroads in nearly all cases: 1. How many men do you employ as car inspectors whose services could probably be dispensed with if the inspection were made for safety only, instead of being made for protection also, as is now necessary under the rules of interchange? 2. Are you in favor of owners being held responsible for the condition of cars except in case of accident or casualty, no repairs to be made except by owners, unless the car is in unsafe condition to run? 3. If so, have you any suggestions to offer as to what shall be considered *prima facie* evidence of unfair usage? 4. If this rule were adopted, would you restrict its application to roads owning a certain number of cars per hundred miles operated? If so, what would be your recommendations? 5. If not in favor of an absolute responsibility of owners, are you in favor of increasing the number of parts included in rule No. 8? If so, please enumerate parts; and, if necessary, conditions. 6. If you would recommend a greater number of parts for which owners are responsible, than those for which they are not, would you recommend changing the rule to read: 'Owners will be responsible for all defects developing under fair usage, except' (giving exceptions you would recommend)? 7. If, in your opinion, these questions do not cover the ground fully, will you please aid the committee by giving your ideas on the subject, regardless of or in addition to the questions?"

COAL CAR SIDES.

"Your committee requests a blue print of your latest design of coal car body, showing in detail the method of bracing the sides, and replies to the following questions: 1. How many cars with sides of this design have you? 2. When were the first of your cars with sides of this design placed in service? 3. What weaknesses, if any, have these sides developed in service? 4. At the present time, do you know of any other design of sides that you consider superior to this one? If so, please send print of it, if possible. Any further information that you may be able to give on the subject will be appreciated by the committee. If you have no cars of this class and no information to offer, please reply to that effect. Please address your reply and send blue print to the Chairman, R. E. Marshall, Broad Street Station, Philadelphia, Pa."

ACTION OF THE AMERICAN RAILWAY ASSOCIATION ON M. C. B. STANDARDS.

The Secretary is advised by letter from Mr. W. F. Allen, Secretary of the American Railway Association, under date of January 17, 1895, as follows:

"At a meeting of the American Railway Association, held on October 17, 1894, the following resolution was adopted:

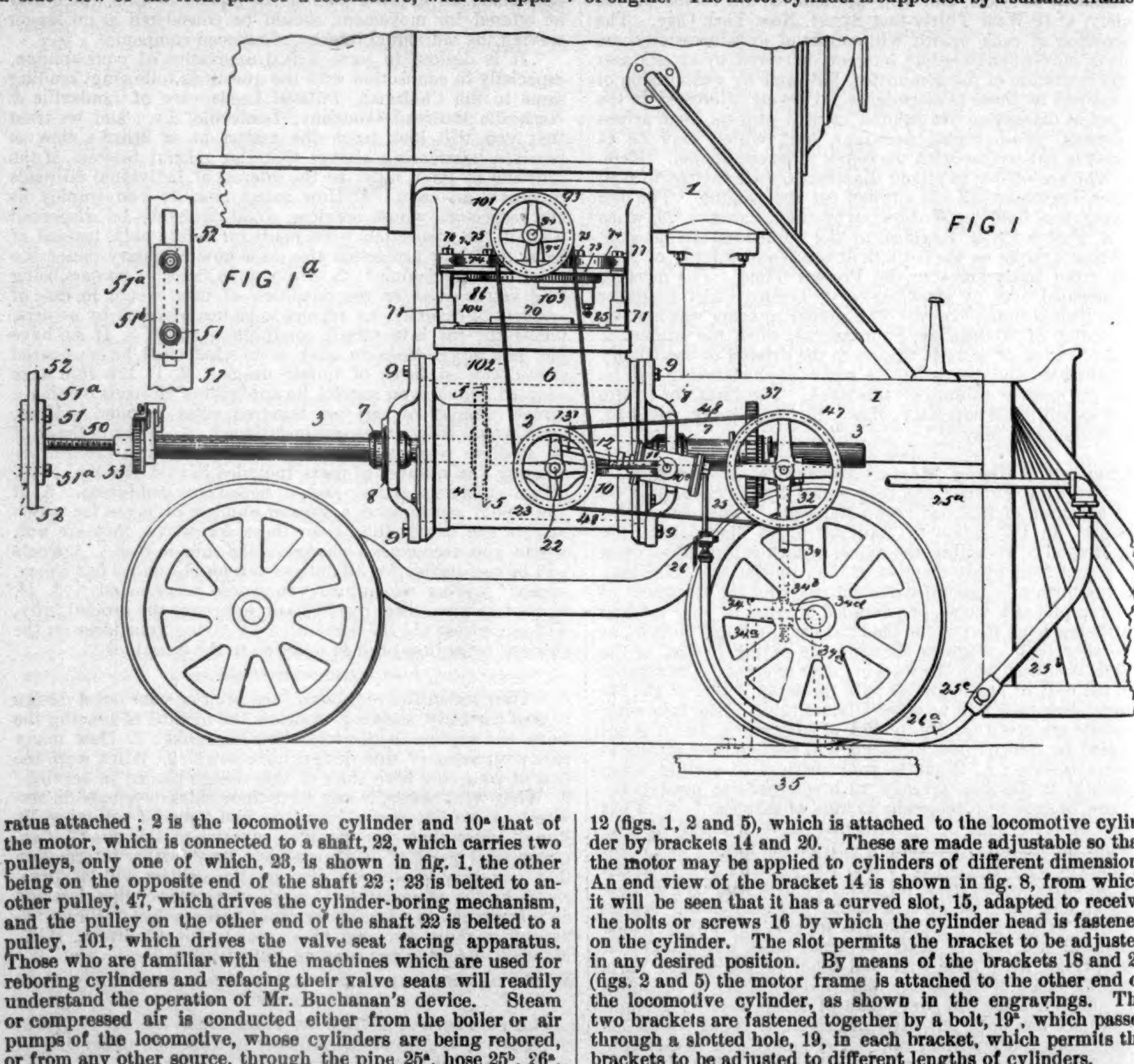
"*Resolved*, That the Details of Car Construction, adopted by the Master Car Builders' Association, as published with the proceedings of its convention, held at Saratoga in June, 1894, be and are hereby adopted as standard by the American Railway Association, and all railway companies and car builders are recommended to conform thereto as soon as practicable.

"In accordance with the instruction of the Association last June, the Executive Committee took up the question of standards with the American Railway Association, and the result has been as above.

"Members are urged to consider the importance of following this matter up and taking up the standards of the Association with the proper officers of their respective companies, and advocate their general adoption."

MECHANISM FOR BORING LOCOMOTIVE CYLINDERS.

MR. JAMES BUCHANAN, Assistant Superintendent of Machinery on the New York Central & Hudson River Railroad, at West Albany, N. Y., has designed and patented an appliance for reboring locomotive and other engine cylinders, and refacing valve seats by power supplied by compressed air or steam obtained either from the locomotive itself or from any other available source. The boring and refacing apparatus which is used is the same as that which is commonly operated by hand. This process was, however, tiresome and tedious, and consumed a great deal of time, during which the locomotive was kept out of service. Mr. Buchanan designed a little oscillating engine with a cylinder 4 in. in diameter, which may be adjustably attached to the cylinders of locomotives, and is adapted for boring those of any size. Fig. 1 represents a side view of the front part of a locomotive, with the apparatus attached; 2 is the locomotive cylinder and 10^a that of the motor, which is connected to a shaft, 22, which carries two pulleys, only one of which, 23, is shown in fig. 1, the other being on the opposite end of the shaft 22; 23 is belted to another pulley, 47, which drives the cylinder-boring mechanism, and the pulley on the other end of the shaft 22 is belted to a pulley, 101, which drives the valve seat facing apparatus. Those who are familiar with the machines which are used for reboring cylinders and refacing their valve seats will readily understand the operation of Mr. Buchanan's device. Steam or compressed air is conducted either from the boiler or air pumps of the locomotive, whose cylinders are being rebored, or from any other source, through the pipe 25^a, hose 25^b, 26^a, and pipe 25 to the motor cylinder 10^a. The supply of steam or air is regulated by a cock, 26.



This appliance has been used for a considerable time in the shops of the New York Central Road, where, as in some other shops, compressed air is employed more and more for handling various kinds of work.

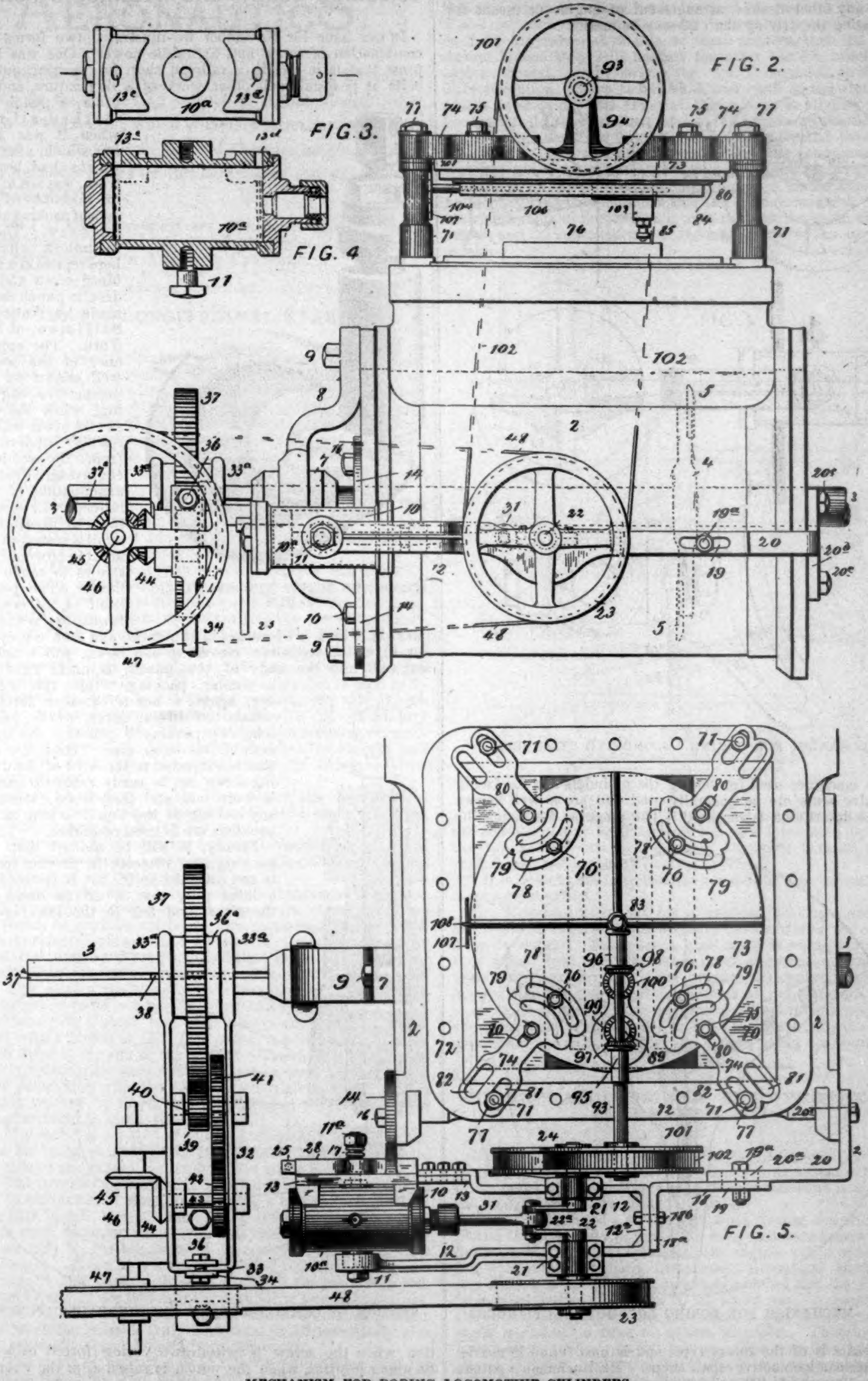
Fig. 2 is an enlarged side view of a locomotive cylinder, 2, and of the motor engine, but with the position of the latter reversed from that in which it is shown in fig. 1. Fig. 3 is a side view and fig. 4 a section of the motor cylinder 10^a. Fig. 5 is a plan view showing the refacing apparatus, the motor engine, and part of the reboring mechanism, with the motor cylinder in the same position as it is shown in fig. 2. Fig. 6 is a still more enlarged side view of the motor engine, looking at the back of it or in the reversed direction from that in which it is shown in fig. 2, and fig. 7 is another side view of the motor, in which it is represented as in fig. 2, but on a larger scale. Fig. 8 is an end view of the motor cylinder and its attachments.

In the illustration the heads of the locomotive cylinder are removed and a boring shaft or spindle, 3, is shown passing centrally through the cylinder. In figs. 1 and 3 a tool carrier, 4, having suitable tools 5 5 for boring the inside surface of the cylinder, is shown on the shaft. Two tools are shown on the carrier in the figures last referred to; but three may be used arranged as shown in the end view of them shown in fig. 9. The shaft 3 is journalled in bearings 7 (figs. 1, 3 and 5) carried by suitable brackets or yokes, 8, which are fastened to the ends of the locomotive cylinder 2 by bolts, 9.

In boring the cylinder the shaft 3 is rotated by the motor engine 10, which might be of any other design, but Mr. Buchanan has adopted the oscillating type as the simplest form of engine. The motor cylinder is supported by a suitable frame, 12 (figs. 1, 2 and 5), which is attached to the locomotive cylinder by brackets 14 and 20. These are made adjustable so that the motor may be applied to cylinders of different dimension. An end view of the bracket 14 is shown in fig. 8, from which it will be seen that it has a curved slot, 15, adapted to receive the bolts or screws 16 by which the cylinder head is fastened on the cylinder. The slot permits the bracket to be adjusted in any desired position. By means of the brackets 18 and 20 (figs. 2 and 5) the motor frame is attached to the other end of the locomotive cylinder, as shown in the engravings. The two brackets are fastened together by a bolt, 19^a, which passes through a slotted hole, 19, in each bracket, which permits the brackets to be adjusted to different lengths of cylinders.

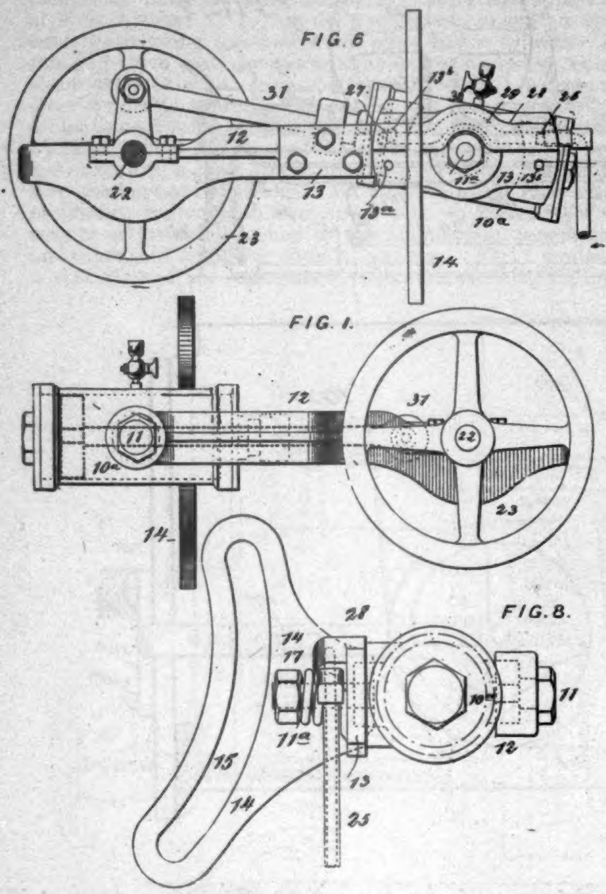
The trunnion 11^a (figs. 5 and 6) is journalled in the plate 13, and is provided with a tension spring, 17, to hold the ports of the cylinder against the plate 13 in a well-known manner. The plate 13 (fig. 6) has exhaust holes, 13^a, 13^b, which are adapted to align alternately with ports 13^c, 13^d, in the cylinder 10^a as it oscillates. The ports 13^c and 13^d in the cylinder are also adapted to alternately align with ports 26 and 27 in a bar, 28, having a steam or air channel, 29, the channel 29 communicating with the pipe 25. The bar 28 is secured to the plate 13 and is bent at 30 to permit the passage of the trunnion or pivot 11^a.

With this arrangement, as the cylinder 10^a oscillates its ports 13^c, 13^d, will alternately align with ports 26 and 27 to receive steam and with holes 13 and 13^a to permit the exhaust to take place; 31 is the piston-rod of the cylinder 10^a, which is



MECHANISM FOR BORING LOCOMOTIVE CYLINDERS.

connected with the crank on shaft 22; but it will be understood that any other desired arrangement of engine or means for operating the driving shaft 22 may be used.



MECHANISM FOR BORING LOCOMOTIVE CYLINDERS.

The machines used for boring the cylinders and for facing the valve seats are so generally used and are so well known that no description is required. The machine for facing the

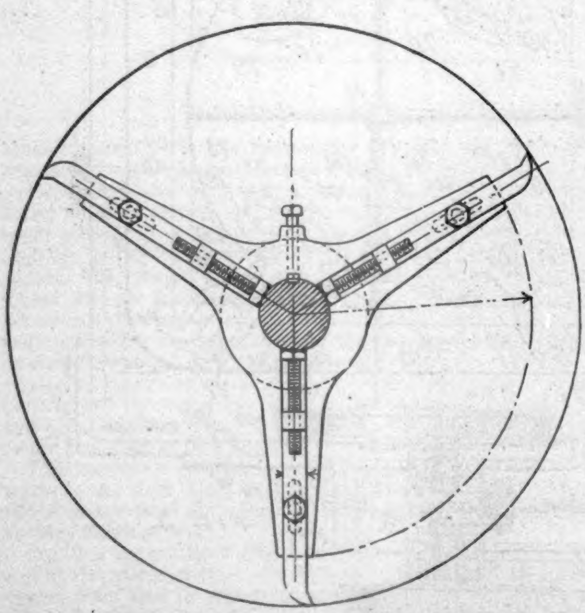


FIG. 9.—MECHANISM FOR BORING LOCOMOTIVE CYLINDERS.

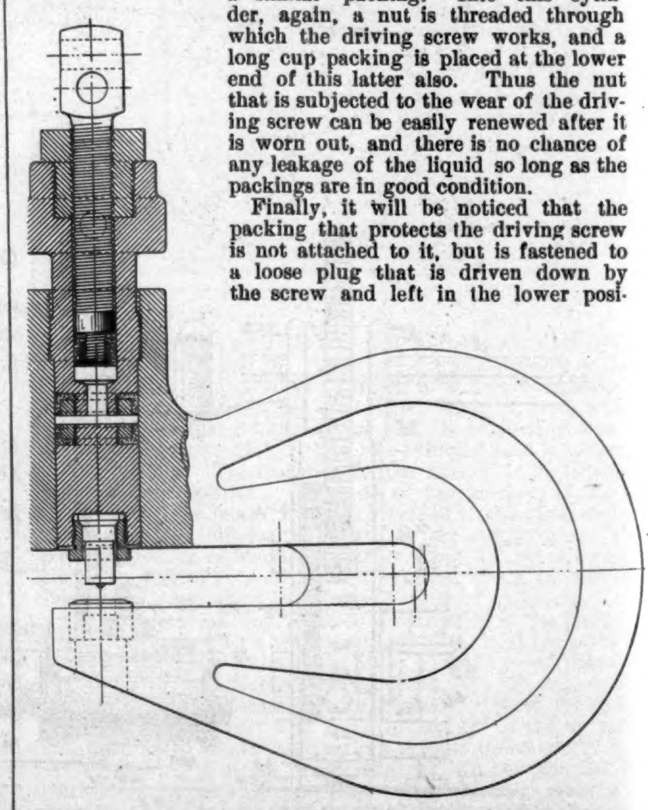
valve seats is of the rotary type, and is now found in nearly all American locomotive repair shops. Mr. Buchanan's patent is dated January 1, 1895, and is numbered 531,773.

COMBINED SCREW AND HYDRAULIC PUNCH.

In our issue for November we illustrated two forms of a combination of screw and hydraulic power. One was for a press that is in use in a railroad shop for pressing out the bolts of pedestals and other work of a like nature, and the other, a punch that worked all right when it was new, but which, after the parts had become worn, was apt to leak on account of the lack of packing about the screw. The illustrations shown here represent a combined screw and hydraulic punch that is made by Watson & Stillman, of New York. The appearance of the tool is well shown by the perspective engraving, while the construction will be readily understood from the sectional engraving. From an examination of this latter it will be seen that no dependence at all is placed on the holding power of the screws to retain the liquid. The punch itself is, of course, furnished with a packing which is of leather in cup form, and then the cylinder in which the screw moves up and down, and which is screwed into the body of the punch, is made tight by a similar packing. Into this cylinder, again, a nut is threaded through which the driving screw works, and a long cup packing is placed at the lower end of this latter also. Thus the nut that is subjected to the wear of the driving screw can be easily renewed after it is worn out, and there is no chance of any leakage of the liquid so long as the packings are in good condition.

COMBINED SCREW AND HYDRAULIC PUNCH.

Finally, it will be noticed that the packing that protects the driving screw is not attached to it, but is fastened to a loose plug that is driven down by the screw and left in the lower position when the screw is withdrawn, being forced back to its upper position when the punch is raised after the work is done.



SECTION OF COMBINED SCREW AND HYDRAULIC PUNCH.

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

AUTOMATIC LONGITUDINAL STABILITY.

WHOEVER has experimented with flying models in the open air knows that the principal difficulty to overcome is that of preserving the longitudinal equilibrium under varying conditions of speed and wind. The bird does this by instinct, through reflex action of the nerves and muscles, aided perhaps by an automatic arrangement not yet understood; but man will need, to secure his safety, a "mechanical brain," which will instantly perceive any change of conditions in the air and apply the proper remedy to preserve the stability.

A good many experiments have been made to effect this with the hanging pendulum; but not only is this slow and weak in action, but it imparts an oscillating motion to the apparatus which is exceedingly objectionable.

In 1891 Mr. Thomas Moy proposed to remedy this difficulty by employing an *inverted* pendulum with a very small range of motion, which should bring into action an *independent force*, to adjust a flying apparatus instantly to the changing conditions. For this he took out British patent No. 14,742 of 1891.

Mr. Moy is a veteran aviator. He tested in 1875 "Moy's aerial steamer," which weighed 216 lbs. and was provided with a steam engine of 3 H.P. This was unable to gain sufficient speed to raise itself from the ground; but this experiment, as well as a subsequent one in 1879 with "Moy's military kite flying machine," satisfied him that the securing of automatic stability was one of the first requisites for success, and after these many years of consideration he brings out the present proposal.

From a paper read by Mr. Moy before the Aeronautical Society of Great Britain, December 15, 1894, we extract the following description of the device:

"Two methods of carrying out my invention are shown in my specifications, and I now propose to describe and explain the simplest of the two methods. . . .

"Referring to fig. 1: Piece 3 is a transverse horizontal shaft projecting outward on each side of the stern portion of the vessel, to port or starboard, the outer ends being fitted with horizontal planes used for steering; 4 is the tiller, the outer end passing through the vertical guide 5 and entering the slot 6 in the rack 7, as also shown in fig. 2. In the position here shown the tiller and the steering planes or rudders are supposed to be in a perfectly horizontal position.

"Piece 8 is a shaft formed in two parts, joined at 9, and fitted with a pinion at 10. This pinion is bored out to receive a ball fitted to the end of the arm 13. The shaft 8 is kept constantly rotating by some source of power, such as clockwork, or by connection with the machinery carried on board or by a treadle worked by the foot of the aviator, very little power being required to rotate the shaft.

"The rack 7 is capable of sliding horizontally in guides, the arms 20 being extended for that purpose; and the pinion 10 and tiller 4 are guided vertically in the guide 5.

"The inverted pendulum 11 is pivoted at 12. The arms 13 and 14 balance each other, each having a ball at its outer end. The bars 15 and 15 limit the play of the pendulum to, say, ½ in. in each direction; but even this limited play of the pendulum may be further reduced by means of electric contact appliances. Piece 16 is a screw-threaded rod fixed to the bars 15 and 15, and passing through a slot in the pendulum rod. Pieces 17 and 17 are two nuts for regulating two light springs, 18 and 18, which keep the pendulum in a vertical position only when the vessel is truly horizontal, but immediately give way when the vessel departs from this course.

"The mode of operation is as follows: Supposing that the vessel is travelling from left to right on an even keel, and that the shaft 8 is turning in the direction of the bent arrow; then the pinion 10 rotates freely between the teeth of the rack 7 and the rack remains stationary. Now, suppose that the head of the vessel rises two or three degrees, then the pendulum immediately falls against the after bar 15, raises the pinion 10, and thereby drives the rack 7 from left to right. This operation lowers the tiller 4, and with it the steering planes on shaft 3. The effect of this will be to slightly raise the stern and to restore the vessel to the horizontal position.

"In order to slow up the vessel gradually and to come gently down to earth, one has only to push the pendulum forward by hand, when the rack 7 will be driven from right to left by the pinion 10; the tiller and steering planes will then be inclined upward, thus bringing the stern downward. The increased angle of inclination at once reduces the speed of the vessel, and it approaches the ground slowly so as to land safely.

FIG. 1

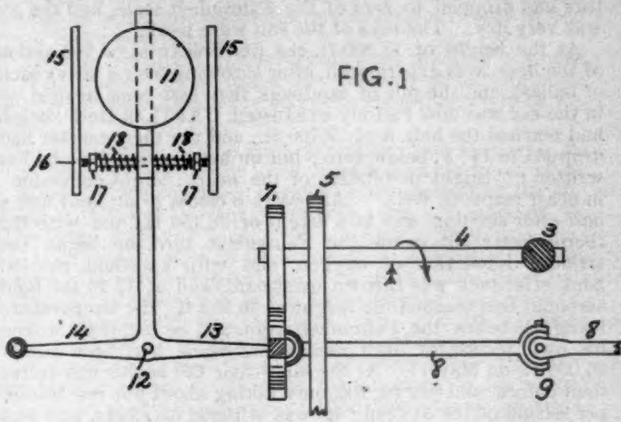
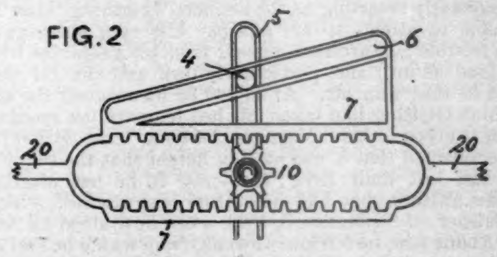


FIG. 2



"In case of an accidental stoppage of the rotating shaft 8, the pendulum may be fixed and the rack 7 operated by hand through a lever attached to one of the guide bars 20, or the shaft 8 may be turned by manual power.

"It is evident that the mechanical details may be varied to a very great extent."

Mr. Moy estimates that for a one-man soaring apparatus the whole of the automatic stability device would not exceed 6 lbs. in weight. There are a good many working parts, but they are all light, and the design is not as complicated as may upon first sight appear. The proposal to apply an inverted instead of a hanging pendulum seems to possess merit; and it is to be hoped that some practical experiment upon an adequate scale will be made to test the value of the device in conferring automatic equilibrium upon a flying apparatus.

THE HIGH ASCENSION OF THE "PHŒNIX" ON DECEMBER 4, 1894.

DR. A. BERSON has published in the *Zeitschrift für Luftschiffahrt und Physik der Atmosphäre*, an authentic description of his latest and exceedingly high balloon ascension made with the *Phœnix* on the 4th of last December.

The prevalence of a strong east wind during the afternoon placed the possibility of making a lofty ascension somewhat in doubt, and it continued through the night; yet in order that the start might be made, Lieutenants Gross and Marker, at five o'clock in the morning, suddenly ordered that the *Phœnix* be inflated with 70,600 cub. ft. of water gas. According to the special purposes of this ascension, it had been Herr Berson's intention to take no others with him. Therefore the heavy 80-lb. anchor was left behind. The drag line, having a length of 650 ft., and weighing by itself 180 lbs., was stretched out over the ground in the direction of the wind, in order that

it might not exert too much of a strain and tend to hold the balloon down at the start. The instruments and attachments were adjusted in the most convenient way possible in order that the observations could be made and registered with the least possible danger of exhaustion at the high altitudes. At 10.28 the command to "Let go!" was given. In 15 minutes the balloon had risen to a height of 6,500 ft. As the direction taken was northwesterly, the whole Hartz range lay on the horizon at the feet of the aeronaut. It was generally foggy, and thick masses of cloud lay over the earth here and there. The temperature at first increased up to a considerable height; at 4,900 ft. the thermometer indicated 5° C. (41° F.). Herr Berson alternately made a double series of readings of his instruments in order that they might be as accurate as possible, cast a glance at his balloon, the lines and the earth, and threw overboard a couple of sacks of ballast. An hour after starting an altitude of 16,400 ft. had been reached; the temperature had dropped to zero of the Fahrenheit scale, and the air was very dry. The rays of the sun were weak.

At the height of 13,800 ft. the first weakness of the action of the heart was experienced, after throwing over a heavy sack of ballast, and the pile of sandbags that had been heaped up in the car was now entirely exhausted. At 11.49 Herr Berson had reached the height of 19,700 ft., and the thermometer had dropped to 14° F. below zero; but on his memorandum he has written: "Slight palpitation of the heart; slight confusion; in other respects, well." At twelve o'clock, or an hour and a half after starting, and at a height of 22,150 ft., and with the thermometer 20° below the Fahrenheit zero, he began the artificial inhalation of oxygen, and with excellent results. Sack after sack was thrown overboard, and at 12.25 the bold aeronaut had reached the height of 26,250 ft., the temperature being 38° below the Fahrenheit zero, and he had thus broken his own record for high ascensions, which had been put at 26,000 ft. on May 11. At the same time the health was better than before, and yet he was only taking about one respiration per second of the oxygen; he was without dizziness, and was in possession of the possibility of continuing his work. So, by constantly resorting to the artificial breathing, Herr Berson was able to attend to his affairs. His eyes alone gave him some trouble; he aroused himself from his sleepiness by a sudden loud shout; and particularly dull and flat did his voice sound in that thin air. At 25,260 ft. he reached the altitude at which Glaisher had taken his last temperature reading, and which is given in his "Voyages Aeriens." At 26,900 ft. Berson recollected that it was at this height that the two Frenchmen had lost their lives; at 27,900 ft. he had attained the greatest altitude that had heretofore been attained, which was by Glaisher on September 5, 1892, when he drained his barometer. About here he fell into a swoon, from which he first awoke after his attendant had checked the balloon from rising higher. After a momentary observation of himself he looked to the condition of the ballast, and then Herr Berson made preparations to rise still higher. The temperature had now fallen to 43° F. below zero. At about 29,500 ft. the balloon finally cut through what he had already observed higher in the heaven, a thin, veil-like strata of cirrus clouds. They did not consist of ice crystals, but of small, perfectly formed flakes of snow. At 12.45, or about 2¼ hours after starting, the barometer stood at a height of only 9½ in., which indicates a height of 31,500 ft., and corresponds to an actual height, in round numbers, of about 30,000 ft. The thermometer had dropped to −54° F.; the quicksilver in the barometer had frozen at −20° F., and the radiation thermometer indicated only −11° F. under the direct rays of the sun.

The balloon was now stationary. There were only one small and six large sacks of ballast remaining, and these were necessary for insuring safety in the descent and landing. The balloon was covered with a thin envelope of snow, pure from the clouds, while above it there was nothing but the cold blue vault of the heavens. The judgment of the investigator told him that it would be safe, by the exercise of proper precautions, to rise 3,000 ft. higher. But he dared not undertake it without the help of an assistant aeronaut to handle the balloon, and so the ascent on this trip was brought to a close. At the greatest height of 30,000 ft. he felt very well, as already stated. When the *Phœnix* had once again reached the height of 29,850 ft., the thermometer being at −52° F., Herr Berson pulled down the small gas valve. The balloon at once began to fall, but stopped again at 24,600 ft., where the valve was reopened. And many another tug at the valve had to be made. While they were still at a height of 27,900 ft., a very crooked river was crossed; it was the Elbe, and near it the landing was afterward effected at Domitz.

The terrible cold now began to have its effect upon his movements, and Herr Berson shivered in his fur coat, and was obliged to crouch down in the car at every instant. The balloon settled down slowly and gently, and only one sack of ballast was thrown out to soften its descent, while at a height of 11,500 ft. Then the rapid reascent of the *Phœnix* was checked by a pull at the valve cord. The earth was now so thoroughly wrapped in clouds that he lost his bearings. As the descent was of some duration, it became possible to make another series of observations. The highest temperature was found at 4,600 ft., where the thermometer registered +43° F. Between this point and the earth it dropped to about +34° F. Herr Berson was for a full hour after the culmination at a height of 17,000 ft., two fingers were frozen, and circulation was only restored in them after an energetic rubbing. The barograph was also injured and stopped by the intense cold.

At three o'clock, as the heavens appeared threatening in the north, the investigator decided to bring the balloon down as rapidly as possible. While he was "swimming" on the upper surface of some cloud waves, at a height of about 1,650 ft., a large city and a steam whistle made itself evident below. At 820 ft. the gray earth appeared through the clouds; the balloon flew over a lake in a gust of wind and landed, by the aid of the inhabitants thereabouts, at 3.45 P.M., in a favorable spot on a ploughed field a short distance west of Kiel on the same evening upon which the patron of the *Phœnix*, the Emperor, stopped at Kiel.

The ascent had occupied 3 hours, and the descent 2 hours and 20 minutes. The important results obtained may be briefly stated to be: (1) the attainment of a greater altitude than any that has heretofore been reached; (2) the observation of an uncommonly low temperature at these heights, and very many wider variations of temperature between the altitudes of 4,900 ft. and 30,200 ft. than we have yet observed in the winter; (3) early and evening-like return of temperature at about 4,900 ft.; (4) the comparatively very slight insulation, even at the greatest height, in contrast with the observations made in May; (5) the perfect interdependence of the proportion of moisture and the fine haze in the heavens in the highest strata of clouds, even at the enormous height of over 32,800 ft; (6) snowflake structure of the cirrus clouds at a height of 29,500 ft.; (7) great increase in the velocity of the wind currents above; which, while it is almost calm on the surface of the earth, sufficed to carry the balloon 186 miles in 5 hours and 17 minutes, corresponding to a velocity of about 54 ft. per second for the average of the whole time.

A PLAN FOR AN AERONAUTICAL CAMP-MEETING.

MR. JAMES MEANS, of Boston, who is greatly interested on the subject of Aeronautics, has issued in the form of a circular, which is reprinted herewith, a proposal to hold an aeronautical camp-meeting some time next summer. We heartily endorse the scheme, and trust it will be carried out. The following is the circular referred to:

"The suggestion, for a definite plan of action which I offered in the *Aeronautical Annual* * have opened an interesting and encouraging correspondence with the students of man flight in various parts of the country which leads me to give further details of the plan.

"These are hereby submitted in a somewhat crude form with the expectation that experimenters will be free in their suggestions for improvements of them.

"There are scores, if not hundreds, of experimenters who, widely scattered, are missing the opportunity of seeing each other's experiments.

"It is probable that a considerable waste of energy occurs in the duplication of experiments.

"If, during the summer or autumn of every year, the experimenters were to assemble for a fortnight at an aeronautical camp-meeting, where all the facilities for their work were provided, much more rapid progress could be made than has been made in the past.

PLACE OF MEETING.

"As for the place of meeting, the necessary seclusion could be found somewhere on Cape Cod; the scarcity of trees there, and the comparative steadiness of the wind also recommend it.

CLASSES OF EXPERIMENTS.

"There should be several classes of experiments, each under the direction of a specialist. For examples:

"*Class I.* Soaring machines launched from captive balloons. (See the *Aeronautical Annual*, 1895, pp. 151 to 168 inclusive.)

* A notice of this will be found on another page.

Two captive balloons could be provided, one of about 10,000 cub. ft, to carry an aeronaut and car; this balloon to be used only in the most favorable weather; another balloon of about 1,200 cub. ft., which, having no aeronaut, could be risked in any weather.

"*Class II.* Kites. Mr. Chanute's 'Progress in Flying Machines' * shows very plainly the great value of experiments with kites. Those who have begun the study and designing of these state that the possibilities of their development are very great.

"*Class III.* Lilienthal machines. Mr. A. M. Herring, of New York,† has already begun to experiment with these, and there are others who intend to begin. Who knows but that Herr Lilienthal himself might be persuaded to make us a summer visit?

"*Class IV.* Experimental flying machines with motors.

"*Class V.* Meteorological experiments. The study of the wind.

"*Class VI.* Aerial screws. Screw-propelled bicycles.‡ Aeroplane bicycles. Testing of fabrics for aeroplanes and kites.§ Experiments to ascertain the solid of least resistance.‖

"During the evenings it would be interesting to have talks given upon various aeronautical subjects.

"Liberal prizes should be offered to those who excel in each class.

"Tent life on the Cape could be made quite agreeable.

"A restaurant tent, a workshop tent, and a large tent for evening talks would be necessary parts of the establishment.

"It would be desirable to build a conical hill such as Lilienthal has had made for himself.¶

"A large and level-boarded area with an incline for starting would be needed for bicycle experiments.

"I do not think there will be any great difficulty in raising the needed money.

"The first step to be taken would be to organize a National Aeronautical Association, and it seems to me the annual dues ought not to exceed \$2 or \$3.

"This scheme can be carried out if a sufficient number of men will volunteer to help in the elaboration of it.

"I am willing to take charge of the soaring-machine experiments and to superintend the raising of the funds.

"If those who are interested will volunteer in the other departments it will make the plan seem quite practicable.

"I shall be glad to have letters from any who wish to take part in study and work in this branch of science which they are likely to find of the most absorbing interest.

"JAMES MEANS.

"BOSTON, MASS."

AERONAUTICAL NOTES.

Kress' Flying Machine.—A newspaper report emanating from Vienna states that at a recent meeting of the German Naturalists' Society a model of a flying machine constructed by Herr Wilhelm Kress was set in motion in the hall, and flew rapidly like a bird up to the gallery.

"Soaring."—It would seem as though the great scientific mystery of "soaring," about which so many books have been written, is about to receive a partial if not perfect solution. Mr. Potter, of Washington, D. C., has already perfected a kite of novel design, which mounts upon the "wings of the wind" and hovers directly over his head. This would seem to be almost a perfect imitation of the bird. The gravity of the kite and string act as the weight of the bird, and the peculiar spread of the kite acts like the wings, while the attachment of the cords serves to balance the kite. The great thing now is to perfect the balancing power, and to make a kite which will mount vertically upward. Mr. Potter is thoroughly alive to this question, and has now projected a kite with very flexible, almost movable wings. We may hope for interesting or even startling results.

* Published by AMERICAN ENGINEER AND RAILROAD JOURNAL, 47 Cedar Street, New York. \$2.50.

† See AMERICAN ENGINEER AND RAILROAD JOURNAL, New York, pp. 50 and 51, January, 1895, number.

‡ It is highly important at the present time to have a bicycle made upon which different screws can be tested when worked by some record-breaking wheelman. In this way we can ascertain how many pounds of push and also of lift can be obtained for each pound of human motor when working under the most favorable circumstances.

§ It will be noticed that some of the experiments in this class can be made indoors when the weather prevents field work.

‖ See Sir George Cayley's article, pp. 47 and 48 of *The Aeronautical Annual* for 1895.

¶ See AMERICAN ENGINEER AND RAILROAD JOURNAL, p. 578 of the December, 1894, number.

RECENT AERONAUTICAL PUBLICATIONS.

THE AERONAUTICAL ANNUAL, 1895. Edited by James Means. Boston: W. B. Clarke & Co. 172 pp., 6 × 9½ in., \$1.

This new publication is apparently a labor of love or enthusiasm for the fascinating art of flying, or perhaps both. In an introductory note the author says: "If this compilation should happily bring any new worker into the field of aeronautical experiment, the hopes of the editor will be amply fulfilled.

"To ask questions of Mother Nature is delectable. If her answers be often non-committal, even such are lures to lead us into better questioning.

"The number of the *Annual* contains not much that is new, but divers things which, to use the words of an old compiler, 'do now for their Excellency and Scarceness deserve to be Reprinted.'"

The frontispiece of the book is a portrait of Leonardo Da Vinci, which is a fac-simile print from a drawing in red chalk by himself. The opening chapter is an account of his life, which is followed by some extracts from a treatise of his "Upon the Flight of Birds." As he died in 1519, this must have been written early in the sixteenth or late in the fifteenth century. The following extract from this old treatise sounds as though it had been part of the proceedings of the Aeronautical Conference held in Chicago in 1893. The distinguished author wrote about three hundred years before:

"When the bird makes his reflex movement above the wind, then he will mount much more than belongs to his natural momentum, seeing that he adds to that the help of the wind, which, entering under him, acts as a wedge. But when he has reached the end of the ascent he will have used up his momentum, and he will have remaining only the help of the wind, which would overturn him, because he strikes it with his breast, were it not that he lowers the right or left wing, which makes him turn to the right or to the left, descending in a semicircle."

After these extracts, three articles on Aerial Navigation, by Sir George Cayley, Bart., written in 1809 and 1810, and which first appeared in *Nicholson's Journal*, are reprinted. In the first of these the author considers the possibility of man flight, and makes observations which are startling to those of us who have thought that the principles of human flight have only been investigated recently. Thus he says:

"The idea of attaching wings to the arms of man is ridiculous enough, as the pectoral muscles of a bird occupy more than two-thirds of its whole muscular strength; whereas in man the muscles that could operate on wings thus attached would probably not exceed one-tenth of his whole mass.

". . . . To produce this effect [the flight of man] it is only necessary to have a first mover which will generate more power in a given time in proportion to its weight than the animal system of muscles.

". . . . The whole problem is confined within these limits—viz., to make a surface support a given weight by the application of power to the resistance of air."

After describing some experiments which he made to ascertain the supporting power of aeroplanes, he says:

"Having ascertained this point, had our tables of angular resistance been complete the size of the surface necessary for any given weight would easily have been determined."

And again: "The flight of birds will prove to an attentive observer that, with a concave wing apparently parallel to the horizontal path of the bird, the same support, and of course resistance, is obtained. And hence I am inclined to suspect that, under extremely acute angles with concave surfaces, the resistance is nearly similar in them all. I conceive the operation may be of a different nature from that which takes place in larger angles, and may partake more of the principle of pressure exhibited in the instrument known by the name of the hydrostatic paradox; a slender filament of the current is constantly received under the anterior edge of the surface, and directed upward into the cavity by a filament above it, in being obliged to mount along the convexity of the surface, having created a slight vacuity immediately behind the point of separation."

In his second article Sir George Cayley describes how the principles which he elucidated may be applied, and discussed at considerable length the question of stability, and in the last article the resistance and power required in both bird and

human flight. The discussion of these principles was thus much earlier than most persons suppose.

The articles quoted from are followed by a reprint of a treatise upon the Art of Flying by Mechanical Means, by Thomas Walker, portrait painter, Hull; a paper on Aerial Locomotion and the Laws by which Heavy Bodies Impelled through the Air are Sustained, read by F. H. Wenham, Esq., at the first meeting of the Aeronautical Society of Great Britain; some extracts from Franklin's correspondence referring to aeronautical matters are also given, and a number of old engravings are reproduced, showing early balloon ascensions. The other reprints are some descriptions of early ascensions by Montgolfier and others; a statement of Langley's law; Darwin's observations of the flight of condors and other birds in South America; an illustration of a machine patented by Mr. Henson in England in 1842, and John Wise's comments thereon; and various curious illustrations relating to aeronautics. The book ends with a Bibliography of Aeronautics, and comments and reports of experiments on the Problem of Man Flight, by the editor. In his comments he seconds the proposal of Mr. Chanute to organize an American Aeronautical Society, and suggests the establishing a camp every summer in some secluded spot where competitive trials of soaring or flying machines could be had. This idea Mr. Means has amplified more fully in the form of a circular, which is reprinted elsewhere.

The *Annual* is an interesting contribution to aeronautical literature, and should have the effect of attracting new workers into the field of aeronautical experiment, which is the object which the editor says he had in view.

AERIAL NAVIGATION. By J. G. W. Fijnje Van Salverda. Translated from the Dutch by George E. Waring, Jr. New York: D. Appleton & Co 209 pp., 4¾ × 7 in.

The translator of this little volume says that it "contains a comprehensive summary, mainly in popular form, of the development of aerial navigation from the balloon of Montgolfier (1783) down to the early stages of the investigations and discussions of Langley, Maxim, Holland, and others." After the introductory chapter there is one on The Military Importance of Aerial Navigation, and others on Balloons for Buoys; The Air Ship in Calm Weather; The Extraneous Obstacles of the Wind; Practical Results already Reached in Machinery for Propelling Balloons; several chapters on the Flight of Birds, one on Atmospheric Currents, and Conclusion. The author aims, as his translator says, to give a summary of what has been done by other investigators and experimenters, and to show in patent phraseology the state of the art at the time he wrote. This is done with a considerable amount of that vague kind of speculation which is assumed to be aeronautical science, but which, it must be confessed, is often tiresome. A tolerably full account is given of the experiments with the balloon *La France* in 1884 and 1885, and in the last chapter the conclusions are stated that Giffard, in 1855, lengthened his balloon, which resulted in great difficulties and disappointments.

In 1872 Dupuy de Lôme made improvements with a view to increasing the stability of his balloon, and applied a small motor to it.

In 1883 Tissandier successfully increased the length of the balloon, and applied a propelling power to it.

In 1885 the balloon of Renard and Krebs "attained the important result that in seven ascents a return was five times made to the point of departure, showing that they five times had complete control of its direction.

Regarding flying machines proper, he concludes, "That a heavy flying machine must clearly be supported by an aeroplane of considerable dimensions, and that the construction of this aeroplane would have to be very strong; that a special motor will be required; that such an arrangement would be unstable; that aerial navigation has now assumed a really scientific character, and that rapid travel in the free air need encounter no serious difficulties—a series of conclusions which seem to be mere platitudes.

The latter part of the book is made up of more or less disjointed extracts from a later pamphlet of Mr. Fijnje, Professor Langley's writings, and an account of an absurd scheme for a flying machine described in *Cassier's Magazine*.

After going through this book the reader may be disposed to doubt the conclusions of the author "that aerial navigation has now assumed a really scientific character."

Atmospheric Resistance. Professor W. L. Webb. *Proceedings Engineers' Club of Philadelphia*, November, 1894. Gives results of tests to determine the resistance of air to the free fall of spheres.

A SNAP-SHOT AT AN ALBATROSS.

SNAP-SHOT photographs have not infrequently added valuable facts to the stores of science. They are able to detect and analyze motions too quick for the eye to follow. A recent instance of the application of photography to settle a disputed question in natural history is an experiment made on a voyage from British Columbia to San Francisco by Mr. A. Kingsmill.

A large albatross had been following the steamer and keeping pace with it for several hours, and the wonder grew among the watchers on shipboard as to how the bird was able to fly so swiftly while apparently keeping its wings extended without flapping them. As this is a common manner of flight with the albatross, the explanation has been offered that the bird takes advantage of slight winds and air currents, and so is able to glide upon what might be called atmospheric slopes.

As the albatross sailed alongside of the ship, about 15 ft. away, Mr. Kingsmill snapped his camera at it, and obtained a photograph which astonished him and his fellow-voyagers.

The photograph revealed, what no eye had caught, the wings of the albatross, each some 5 ft. long, raised high above its back in the act of making a downward stroke. The explanation naturally suggested is that, more or less frequently, the bird must have made a stroke of this kind with its wings, although the eye could not detect the motion, and that the camera chanced to be snapped just at the right moment.—*Youth's Companion.*

We are inclined to place an interrogation mark (?) after this statement.—EDITOR AERONAUTICS.

Balloon Reconnoissance.—The other form of reconnoissance—aerial, that from balloons—has, whenever it has been found practicable, proved to be of the greatest value; but the tempestuous weather has prevented its frequent employment. On this account there is a dead set against balloons, and there are heard many growls against allotting any portion of our scanty transport for the carriage of that which can so seldom be used. If any one wishes to be convinced how penny-wise and pound-foolish we should be to abandon this but lately started form of reconnoissance, let him take the whole of the battles of 1870–71 and sit down and calculate not only what would have been the saving in blood, but in hard money if, on any one of those days, either side had been able to send up a balloon with practised observers in the car. It is because in peace time the inestimable value of information regarding the enemy's dispositions is not realized; it is because dispositions based on defective or incomplete information are not paid for as they are in war, with defeat and loss of lives, that soldiers fail to understand the full value of accurate information. Moreover, at Aldershot the balloon has never had a fair trial; it has been employed for mere tactical work and not for the manœuvring work, and this because the latter has not existed. It is sent up simultaneously with the advance of the troops to the battlefield instead of being sent up at daybreak to obtain information as to whither that advance should be. When our training resembles the work of modern war, and when manœuvring occupies the foreground, loud will be the demands for a balloon. But even when used tactically it has been a success. At the operation near Chobham Ridges on July 25 the balloon observers reported to the attacking force an approaching strong counter-attack. So little did the general know of his enemy's dispositions that he would not believe the report. Shortly afterward, however, the counter-attack took place. On two other occasions the balloon observers kept their side constantly informed of the dispositions of the hostile forces in the battle. The balloon now works in conjunction with the field telegraph; written reports are passed down by "messengers" along the cable of the captive balloon to mother earth, where a telegraph station is ready for their reception. The other end of the telegraph wire has been carried to the point in the battlefield where the general has taken up his stand; if he shifts, the wire is laid on to his next position, so that the balloon itself can remain well in the rear of the fight and yet communicate rapidly with the commander. It may be here mentioned that another form of aerial reconnoissance is in the experimental stage; it consists in raising the observer by means of a kite, the contention being that the worse the weather for the balloon, the more suitable it is for the kite. Both Lieutenant Baden-Powell, of the Scots Guards, and Captain Pilcher, of the Northumberland Fusiliers, are engaged on working out this problem, each in his own way, but at present neither solution has reached the practical stage.—*London Times.*